

## *Code Enforcement Department*

### **Guidelines for Design, Installation, and Construction of Food Establishments in North Carolina**

These references are intended to provide guidance and assistance in complying with North Carolina requirements and nationally recognized food safety standards. Included are design, installation and construction recommendations regarding food equipment and facilities. The goal is to promote the uniform design and construction of food facilities which are not only conducive to safe food handling and sanitary facility maintenance but which encourage both.

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## **SECTION 1 - FACILITIES TO MAINTAIN PRODUCT TEMPERATURE**

Sufficient hot-holding and cold-holding facilities shall comply with North Carolina and NSF standards (National Sanitation Foundation), and shall be designed, constructed and installed in conformance with the requirements of NSF standards. (UL Sanitation, ETL Sanitation listed equipment is considered equivalent to NSF standards).

### **REFRIGERATION FACILITIES SIZING AND DESIGN**

Refrigeration facilities shall be adequate to provide for the proper storage, transportation, display, and service of potentially hazardous foods. Specific refrigeration needs are based upon the menu, number of meals, frequency of delivery, preparation in advance of service.

1. All potentially hazardous foods requiring refrigeration shall be kept at or below 45 °F except when being prepared or served.
2. Walk-in freezers shall be designed, constructed and maintained to keep frozen foods frozen. Temperature indicating devices will be required.

Point-of-use refrigerators should be provided at workstations for operations requiring preparation and handling of potentially hazardous foods. Refrigeration units, unless designed for such use, shall not be located directly adjacent to cooking equipment or other high heat producing equipment, which may tax the units cooling system.

### **SIZING CONSIDERATION FOR CALCULATING TOTAL REFRIGERATED STORAGE NEEDS INCLUDING WALK-INS AND REACH-INS**

To plan reserve storage, the following will need to be considered: menu, type of service, number of meals per day, number of deliveries per week.

The following is a suggested formula to establish required reserve storage for walk-in refrigeration units. (Note: only 40% of any walk-in unit actual provides usable space):

Total Interior Storage Volume Needed:

$$\frac{\text{Vol. per meal (Cu. ft.)} \times \text{number of meals}}{40\% \text{ usable Space}}$$

Below are typical meal volumes for each of three types of refrigerated storage:

Meat and Poultry	=	.010 - .030 Cu. ft. per meal
Dairy	=	.007 - .015 Cu. ft. per meal
Vegetables and fruit	=	.020 - .040 Cu. ft. per meal

Thus for a restaurant serving 1000 meals between deliveries (assume a minimum of 4 day storage) the following storage capacities are needed:

Meat refrigerated storage	=	$\frac{.030 \text{ cu. ft./meal} \times 1000 \text{ meals}}{.40}$	= 75 Cu. Ft.
Vegetable refrigerated storage	=	$\frac{.040 \text{ cu. ft./meal} \times 1000 \text{ meals}}{.40}$	= 100 Cu. Ft.
Dairy refrigerated storage	=	$\frac{.015 \text{ cu. ft./meal} \times 1000 \text{ meals}}{.40}$	= 37.5 Cu. Ft.

To calculate the interior storage space required for the above example in square feet, simply divide the cu. ft. (volume), in each case, by the height of the unit.

$$\text{Example for meat storage} = \frac{75 \text{ cu. ft.}}{6 \text{ ft. (height)}} = 12.5 \text{ sq. ft. of interior floor area would have to be}$$

provided to accommodate storage of meat for 1000 meals. To estimate total interior volume or space, add the requirements for each type of food. To convert interior measurements to exterior floor area simply multiply by 1.25. Thus, for meat storage, in the above example exterior floor area =  $1.25 \times 12.5 \text{ sq. ft.}$ , or 15.6 sq. ft. would be needed. (Refer to Appendix A-1 pages (A-1) 1 - 6 for Refrigerated Walk-In Storage Charts)

The following is a suggested formula to establish required reserve storage for reach-in refrigeration units. (Note: only 75% of any reach-in unit actually provides usable space):

Total Interior Storage Volume Needed:

$$\text{Vol. per meal (Cu. ft.)} \times \text{number of meals} \times 75\% \text{ usable Space}$$

Thus for a restaurant serving 1000 meals between deliveries (assume a minimum of 4-day storage) the following storage capacities are needed: (Refer to Appendix A-1 pages (A-1) 7 – 12 for Reach-In Refrigerated Storage Charts)

$$\text{Meat refrigerated storage} = \frac{.030 \text{ cu. ft./meal} \times 1000 \text{ meals}}{.75} = 40 \text{ Cu. Ft. unit}$$

$$\text{Vegetable refrigerated storage} = \frac{.040 \text{ cu. ft./meal} \times 1000 \text{ meals}}{.75} = 53 \text{ Cu. Ft. unit}$$

$$\text{Dairy refrigerated storage} = \frac{.015 \text{ cu. ft./meal} \times 1000 \text{ meals}}{.75} = 20 \text{ Cu. Ft. unit}$$

## **ADDITIONAL REQUIREMENTS FOR REFRIGERATED STORAGE FACILITIES**

**A.** Shelving for walk-ins and reach-ins shall be NSF Standard #7 (for refrigeration use) listed or equivalent for use.

**B.** Interior finishes of walk-in and reach-in refrigeration units that comply with the requirements of NSF Standard #7 or equivalent would be acceptable except for galvanized metal, which is not recommended because of its tendency to rust.

All refrigeration units must have numerically scaled indicating thermometers accurate to  $\pm 3^{\circ}\text{F}$  with the temperature-sensing unit located in the unit to measure air temperature in the warmest part. All such thermometers should have an externally mounted indicator to facilitate easy reading of the temperature of the unit.

**C.** Refrigerators and freezers shall be capable of maintaining appropriate temperatures when evaluated under test conditions specified under NSF Standard #7 or equivalent. Maximum operating temperature (cabinet air) shall be:

<b><u>Max. Compressor Type</u></b>	<b><u>Max. Temp</u></b>
Rapid Cool down	Food temp cooling from 140°F to 45°F within 4 hours
Refrigerated Buffet units	Cabinet air temp 33-41°F Food temp 45°F
Storage & display Refrigerators	Cabinet air temp 41°F
Storage & display Freezer	Cabinet air temp 0°F

- D.** Approved cove juncture base shall be around the interior.
- E.** Approved cove junction base shall be around the exterior.
- F.** Approved enclosure between the top of the unit and the ceiling will be required as per manufacturer specification.
- G.** Outside remote refrigeration units shall be for unopened standard packaged goods only. These units shall meet National Sanitation Foundation or equivalent.
- H.** If the walk-in floors are water-flushed for cleaning or receive the discharge of liquid waste or excessive melt water, the floors shall be non-absorbent (i.e. quarry tile or equal) with silicone or epoxy impregnated grout, sloped to drain outside of the box to a floor drain or trench drains located within 2 feet of the cooler door.
- I.** All walk-in units shall be constructed and installed in accordance with NSF standards, and the NSF "Manual on Sanitation Aspects of Installation of Food Service Equipment". (Refer to Appendix B for the NSF "Manual on Sanitation Aspects of Installation of Food Service Equipment".)
- J.** Walk-in units should contain moisture-proof lamps providing a minimum 10 foot candles of light at 30" above the floor.

## **HOT HOLDING AND REHEATING FACILITIES**

The hot holding facilities must be capable of maintaining potentially hazardous foods at an internal temperature of 140° F or above during display or holding.

Reheating equipment must be capable of raising the internal temperature of potentially hazardous foods rapidly to at least 165° F. Appropriate product thermometers will be required to monitor temperature.

As recommended by the FDA microwave reheating of PHF's (Potentially Hazardous Foods) shall be at least 190° F.

## **SECTION 2 - FACILITIES TO PROTECT FOOD**

### **FOOD PREPARATION SINK**

Adequate facilities must be provided to promote good hygienic practices, sanitary food handling and to minimize the potential of cross contamination between finished and raw products. Separate areas should be designed to separate food handling operations involving raw and finished products.

Separate vegetable washing facilities shall be provided in establishments that wash raw vegetables. Where it can be documented by low volume, infrequent preparation or where items are purchased prewashed and pre-packaged, a separate preparation sink may not be required.

Establishments that scale or eviscerate fish, wash raw poultry, or other raw meats shall provide separate sinks with preparation space for these processes. Where it can be documented by low volume, infrequent preparation or where items are purchased prewashed and packaged a separate preparation sink may not be required.

**For facilities that have a low volume of vegetables, fish, poultry or other raw meats that are being prepped or washed then the operator may want to install a chief table to accommodate this operation.**

The minimum recommended drainboard length for food preparation sinks when installed is 18".

Where portable chopping boards are used these items must be NSF listed or equivalent and should be coded or labeled for specific use.

All food on display, during service or while being held must be adequately protected from contamination by the use of: packaging; serving line, storage or salad bar protector devices; display cases or by other effective means including dispensers.

Sneeze guards shall comply with the standards of NSF or equivalent.

**(See Appendix A-6 for Sneeze Guard Installation)**

Where frozen desserts are being portioned and dispensed, running water dipper wells should be provided for the in-use storage of dispensing utensils. **(Dipper wells are not recommended for other than the above described use)**

### **SECTION 3 - DRY STORAGE CONSIDERATIONS**

The dry storage space required depends upon the menu, number of meals, quantities purchased and frequency of delivery. The location of the storeroom should be adjacent to the food preparation area and convenient to receiving. Where possible the storeroom should be free of uninsulated steam and water pipes, water heaters, transformers, refrigeration condensation units, steam generators or other heat producing equipment. Temperatures of 50° F to 80° F are recommended. Foods shall not be stored under exposed sewer lines due to the possibility of contamination from leaks in the overhead lines.

Two suggested formulas used in estimating required storage space is as follows:

#### **Formula # 1**

$$\text{Linear feet of shelving for storage (ft.)} = \frac{\text{volume per meal} \times \text{number of meals between deliveries}}{D \times H \times C}$$

Volume per meal = .025 to .050 cu. ft. per meal served

D = Depth of the shelves in feet

H = Clearance between shelves in feet

C = 80% effective capacity of shelf height

For example assume 400 meals per day and a 10 day storage between deliveries = 4000 meals for which to provide storage, Volume of .035 per meal, shelf depth of 18 inches, clearance of 18 inches between shelves and 80% effective capacity of shelf height:

$$\text{Linear feet of shelving for storage (ft.)} = \frac{.035 \text{ cu. ft} \times 4000 \text{ meals}}{1.5 \text{ ft.} \times 1.5 \text{ ft.} \times 80\%} = 77.77 \text{ Linear feet}$$

#### **Formula #2**

$$\text{Required Storage Area (sq. ft)} = \frac{\text{Volume per meal} \times \text{number of meals between deliveries}}{\text{Average height} \times \text{fraction of usable storeroom floor area}}$$

(1) Volume per meal = .025 to .050 cu. ft. per meal served

(2) Useful storage height = 4 to 7 feet

(3) Storage time between deliveries = 3 to 14 days

(4) Fraction of useable storeroom floor area = .3 to .6

For example assume 100 meals per day and a 10 day storage between deliveries = 4000 meals for which to provide storage:

$$\text{Required Storage Area} = .05 \text{ cu. ft.} \times 1000 \text{ meals} \times 5 \text{ ft.} \times .3$$

$$\text{Required Storage Area} = 33 \text{ square feet}$$

**(Refer to Appendix A-3 pages (A-3) 1 – 18 for Dry Storage Charts for Formula 1 & 2 )**

Shelving, dunnage racks in dry storage areas should be constructed to meet NSF or equivalent standards. Clearance between the shelves should be at least 12" to 18". Sufficient moveable dunnage racks and dollies (with smooth surfaces, cleanable in case of food spillage or package breakage) should be provided to store bulk food or bulk containers at least 12" above the floor for fixed storage shelves and 6" for portable storage units.

Dunnage racks, etc. should be spaced from walls sufficiently to prevent vermin harborage, monitoring and inspection. Food containers shall not be stored under exposed sewer lines or leaking water lines. Approved food containers with tight-fitting covers are required for storing broken lots of items such as flour, cornmeal, sugar, dried beans, rice and similar foods. Scoops are recommended for each food storage container in use.

**Facilities that have a large amount of take-out or use single items will need to increase the amount of storage in order to handle these items.**

In order to estimate the amount of additional space need to accommodate these items it is recommended that the amount of dry storage calculated utilizing either formula 1 or 2 be increased by 10% to 25 %

## **SECTION 4 - HAND WASHING**

### **HAND WASHING FACILITY**

Lavatory facilities shall include hot and cold running water supplied through a combination faucet or tempered water, sanitary towels or approved hand drying devices, and soap. Anti-bacterial soap should be provided at each employee lavatory facility.

Any self-closing or metering faucet should be designed to provide a flow of water for at least 15 seconds without the need to reactivate the faucet.

For employees, at least one lavatory facility shall be provided in the kitchen area in addition to any lavatories which may be provided in the toilet rooms. Additional lavatories may be required in food preparation or utensil washing area which are more than 25' from a lavatory or when the food preparation areas or utensil washing facilities are located in a separate room.

Splashguard protection is required if spacing to adjoining food, food contact surfaces, or utensil washing and storage area surfaces are less than 18 inches. Splash guards shall not hinder access to the lavatory, should extend from the front of the sink to 12 inches above the rim of the sink, and be of easily cleanable construction.

Lavatory facilities shall remain free of storage, shall be used exclusively for hand washing and shall be kept clean and in good repair.

Figure 1 illustrates a typical hand wash installation with a splash guard.

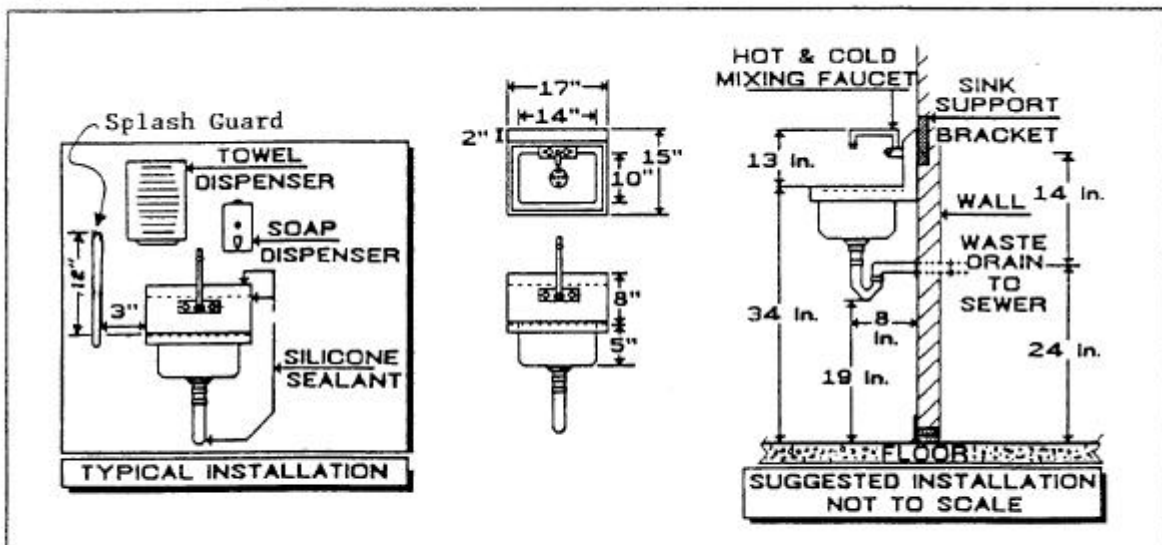


Figure 1

## **SECTION 5 - WATER SUPPLY AND SEWAGE DISPOSAL**

Where a non-municipal water supply or sewage disposal system is utilized, the location of these facilities shall be noted on the plans and certification provided that state and local regulations are to be complied with.

### **WATER SUPPLY**

Enough potable water for the needs of the food service establishment shall be provided from a source constructed and operated according to **Standards** Title 15A Subchapter 18A of the North Carolina Administrative Code .1700 - Protection Of Water Supplies; or the **Rules Governing Public Water Systems** Title 15A Department of Environment, Health, And Natural Resources Subchapter 18C Sections .0100-. 2100. - Water Supplies.

Cross-connections with sewage lines; unapproved water supplies or other potential sources of contamination are prohibited. Hot and cold running water under pressure shall be provided to food preparation, utensil and handwashing areas, and any other areas in which water is required for cleaning. Running water under pressure shall be provided in sufficient quantity to carry out all food preparation, utensil washing, hand washing, cleaning, and other water-using operations.

### **SEWAGE DISPOSAL**

All sewage including liquid waste shall be disposed of by a public sewage system or by a sewage disposal system constructed and operated according to Federal Standards 40 CFR 403.5; State **Laws And Rules For Sewage Treatment And Disposal Systems** Title 15A of the North Carolina Administrative Code, Subchapter 18A, Section .1901-. 1968 - Sewage Treatment And Disposal Systems.

Wastewater from food service equipment such as utensil wash sinks, prep sinks, dishmachines and other equipment that discharge liquid wastewater should be discharged to a sanitary Floor-Type sink wastewater receptor as illustrated below in

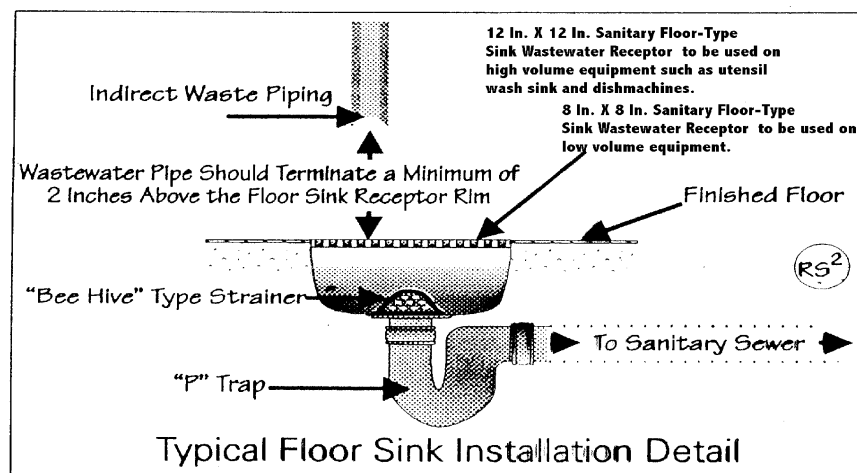


Figure #2

## **SECTION 6 - EQUIPMENT AND INSTALLATION**

All equipment in food establishments shall be NSF (National Sanitation Foundation), UL Sanitation, ETL Sanitation or equivalent, and shall be designed, constructed and installed in conformance with the requirements of NSF standards.

Equipment shall not be located under exposed or unprotected sewer lines, open stairwells or other sources of contamination.

Equipment should be installed in accordance with the NSF "Manual On Sanitation Aspects Of Installation Of Food Service Equipment" or equivalent .

The following outlines some of the equipment installation requirements to insure proper spacing and sealing to allow for adequate and easy cleaning:

Food equipment shall be installed as follows:

1. Counter-mounted equipment shall be on 4-inch sanitary legs, sealed to the counter or be portable.
2. Floor-mounted equipment shall be on 6-inch sanitary legs, on casters, or sealed to the floor.
3. Equipment not on casters or not portable shall be sealed to the wall and/or adjoining equipment, or spaced to facilitate cleaning.
4. Portable equipment and equipment installed on casters shall be installed with flexible utility lines and/or quick-disconnect couplings.

The above criteria shall be applied to permit all exposed areas of equipment and adjacent surfaces to be accessible for cleaning. If an item of equipment is not portable, is not installed on casters, or is not otherwise easily moved, it shall be (1) sealed to adjoining surfaces with an approved sealant or metal flashing, or (2) provided with sufficient space between and behind the equipment to allow easy access.

### **Installation Requirements for Dishwashing Equipment**

Install dishwashing equipment and drainboards a minimum of 3 inches from any adjacent wall area. Drainboards may be manufactured with continuous side and back splashes and mounted directly to the adjoining wall area.

Backsplashes must adjoin the wall within 1/32 of an inch and be caulked and sealed to create a smooth, sanitary, vermin proof installation. Where equipment does not effectively adjoin the wall within 1/32 of an inch it should be installed a minimum of 3 inches off the wall.

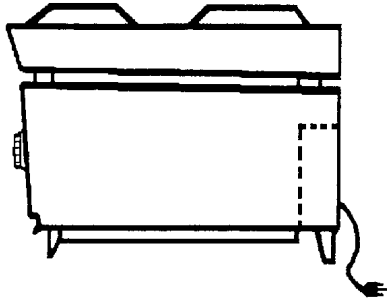
Soiled Drainboards are recommended to be located a minimum of 18" from food contact surfaces or equipped with splash protection.

Splashguard protection is required if spacing to adjoining food, food contact surfaces, or utensil washing and storage area surfaces are less than 18 inches. Splashguards shall not hinder access to the lavatory, should extend from the front of the sink to 12 inches above the rim of the sink, and be of easily cleanable construction.

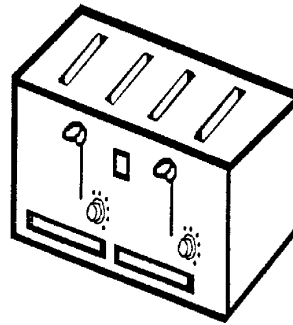
## **Portable Equipment**

Food equipment that is small and light enough to be easily moved by one person shall be considered portable and is exempt from equipment installation requirements.

(Figure 3 illustrates some examples of portable equipment. The hot plate and toaster are both equipped with an electrical connection that can be disconnected.)



**Electric Hot Plate**



**Toaster**

**FIGURE 3.**

## **Counter Installation of Equipment**

Food equipment, which is not readily movable because of size, weight, or rigid utility connections, shall be installed on counters or tables as follows:

1. On 4-inch sanitary legs; or
2. Sealed to the counter; and
3. Properly spaced to facilitate cleaning; or
4. Equipped with an integral lift lever, pivoting foot, polyethylene wear strips, or a similar device, which allows easy access under and around the equipment for cleaning.

## **Undercounter Installation of Equipment**

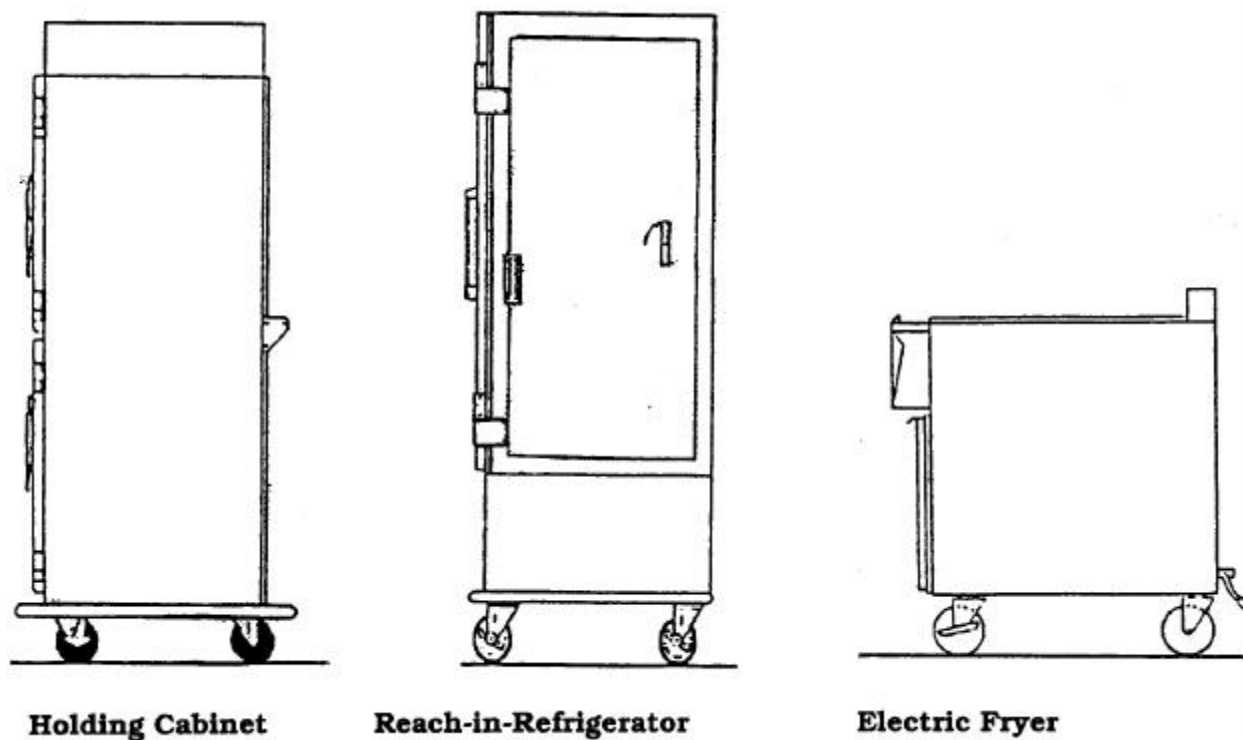
Undercounter equipment installed on the floor shall be equipped with casters or sanitary skids, or on 6-inch sanitary legs and sealed to adjacent surfaces or properly spaced to facilitate cleaning.

## **Casters**

Casters shall be properly sized for the equipment served, and should be compatible with the cleaning materials used. It is strongly recommended that equipment be installed on casters when possible. Equipment installed on casters allows easy movement and facilitates the cleaning of surrounding surfaces and equipment. Casters also allow for maximum utilization of space by reducing or eliminating spacing requirements for cleaning.

Casters can be installed on most food equipment, including ice machines and deck ovens. Flexible or quick-disconnect couplings are needed on caster-mounted equipment with utility connections. Due to safety concerns, some tilting braising pans, equipment receiving direct steam lines, and some top-heavy equipment should not be installed on casters. Casters may not be the appropriate when floors are severely degraded.

**(Figure 4 illustrates equipment on casters.)**



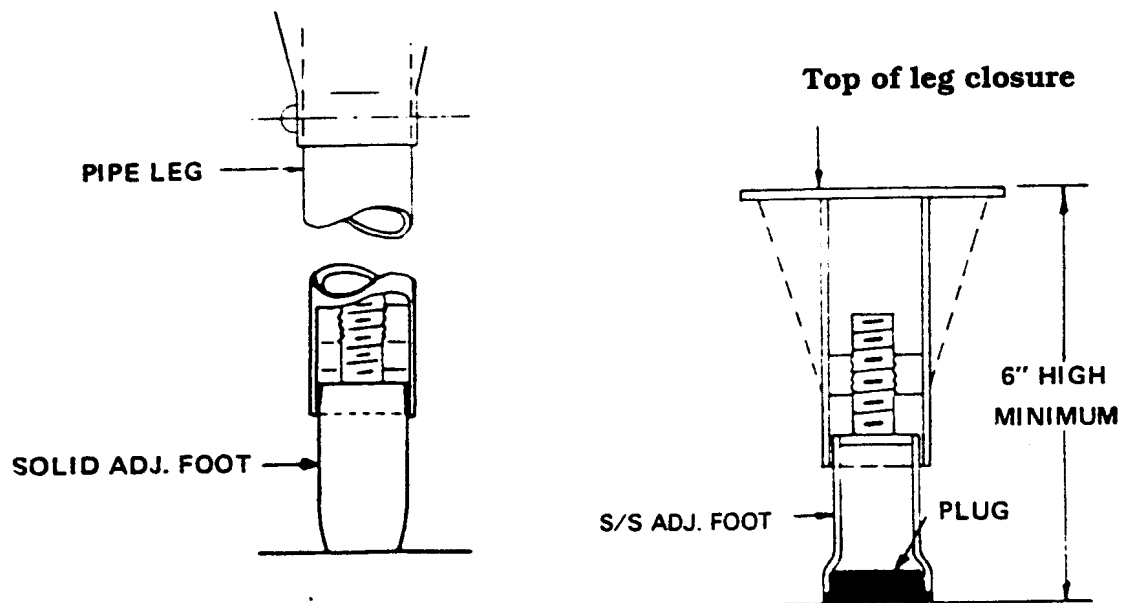
**Figure #4**

## **Sanitary Legs**

When equipment is supported on legs and installed on the floor, the legs shall:

1. Provide at least six inches of unobstructed space between the equipment and the floor;
2. Be of a design that is easily cleanable and constructed of approved materials; (Angle iron, bricks, and concrete blocks are not approved)
3. Be arranged and built to prevent internal harborage of vermin or accumulation of liquids and debris;
4. Provide a minimum of interference with cleaning at the leg-floor contact,
5. Contain no exposed threads, or embellishments, or overhanging edges that serve as places for accumulation of dust, dirt, and debris.

(Figure 5 illustrates equipment with Sanitary Legs.)



**FIGURE 5.**

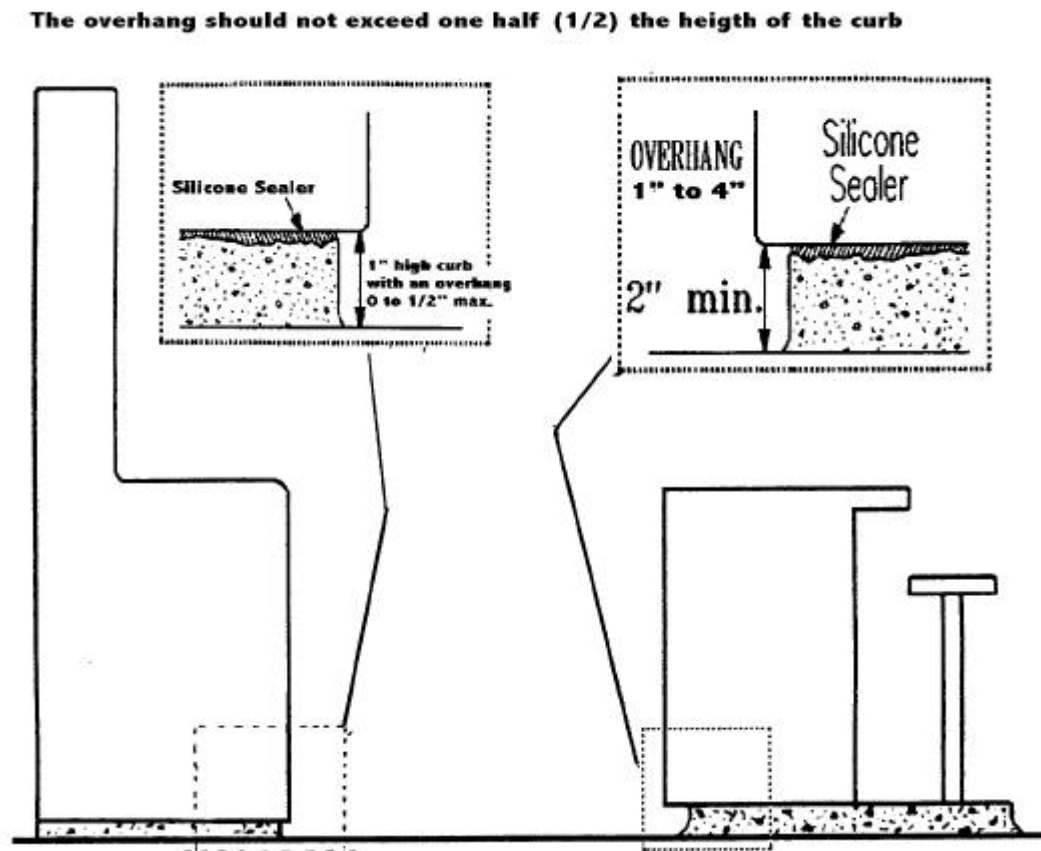
It is desirable for the legs to be adjustable.

## **Masonry Islands**

Island installation of equipment reduces the total floor area that must be cleaned. Masonry islands should be a minimum height of six inches with a cove of at least 1/4" inch radius at the juncture of the island and the floor. The edges of the equipment should overhang the island (but not more than the height of the island) to prevent grease or other liquids which may spill over or run down the sides from running underneath. The juncture between the base of the equipment and the island shall be sealed to prevent vermin harborage.

Remember to plan for a of 30 inches minimum and 36 inches preferred for a single aisle, 48 inches minimum and 60 inches preferred for a double aisle.

(Figure 6 illustrates a single aisle curb based installation.)

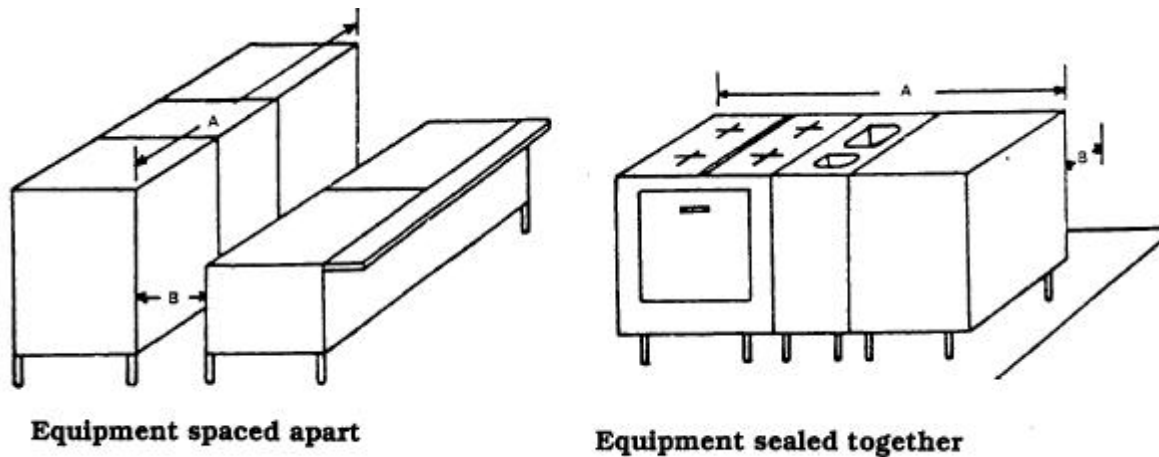


**FIGURE 6.**

## **Spacing Requirements for Food Equipment**

Equipment not readily movable or sealed to adjacent surfaces shall be spaced to allow access for cleaning. The amount of space required between and behind equipment depends on the size of the equipment and the accessibility needed for cleaning the equipment and adjacent surfaces.

(Minimum space requirements for food equipment installation are as illustrated in figure 7.)



**FIGURE 7.**

1. Provided access is available from both ends of the equipment and the total equipment length is four feet or less (A), the equipment shall be spaced at least six inches from walls and other equipment (B).
2. Provided access is available from both ends of the equipment and the total equipment length is over four feet but less than eight feet (A), the equipment shall be spaced at least 12 inches from walls and other equipment (B).
3. When the total equipment length is eight feet or more (A), the equipment shall be spaced at least 18 inches from walls and other equipment (B).
4. A minimum of six inches of space shall be provided between items of equipment to allow access for cleaning. Additional space may be required for large equipment when six inches is not adequate to provide access.
5. Obstruction of the access opening between and/or behind equipment by a chase or rigid utility connection may require additional spacing.

## **Floor Attachment of Equipment**

Equipment placed directly on the floor, such as counters, display cases, cabinets, proofers, ovens, large cooking kettles and retarders shall be effectively sealed to the floor using silicone, metal flashing, vinyl coved base, or other approved material. Metal kick plates which are readily removable will not be required to be sealed to the floor, provided the base of the equipment is sealed to the floor or the areas behind the kick plates are easily cleanable.

**(Figure 8 illustrates floor-mounted equipment.)**



**Cooking Kettle**



**Bakers Oven**

**FIGURE 8**

## **Wall Attachment of Equipment**

Equipment attached to walls, such as lavatories, preparation sinks, utensil washing sinks, dish tables, counters, and cabinets shall be effectively sealed to the wall to prevent splash, debris accumulation, and vermin harborage. Note: any combination of low profile or pan head bolts, screws, rivets, silicone sealers, or flashing that effectively closes the opening between the equipment and the walls in a smooth and sanitary manner is acceptable.

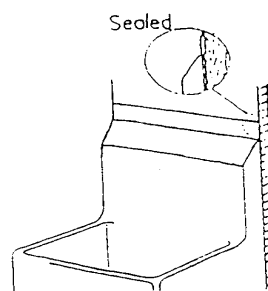
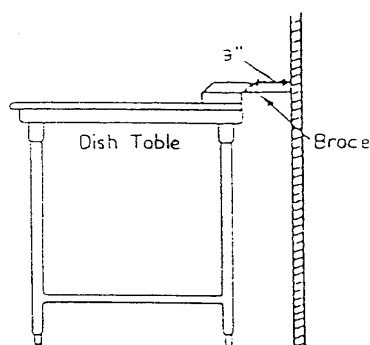
If the equipment is open underneath, such as a drainboard, dish table, or open base table, it may be installed at least three inches away from the wall. This provision is made due to the fact that dish tables, drainboards, and immobile open base tables are accessible underneath the counter top and a space of three inches from the wall to the equipment is enough to facilitate cleaning.

(Figure 9 illustrates both of these installations.)

**Table**

**Hand Sink**

**FIGURE 9.**



### **Free Standing Attachment**

Utensil wash sinks, prep sinks or any sink that requires water to the unit can be either mounted to the wall or off the wall. The equipment can also be installed free standing (not attached or bracketed off) if the equipment is installed with flexible water lines that allow for the unit to be pulled 6 to 12 inches away from the wall for cleaning. This method will allow for easier installation and will prevent the problem of having to replace the sealant on a wall attached unit approximately every year. **(Figure 10 illustrates this installation.)**

### **Sink with flexible water lines and wasted indirectly to a floor sink**



**Figure 10**

In cases where the space between the equipment and the wall is too large for use of a silicone sealant, metal or other approved flashing is necessary for an effective seal. Examples of equipment that frequently require metal flashing are walk-in coolers and freezers, retarders, proofers, and large ovens. Some installations may require a combination of flashing and silicone sealant.

Equipment mounted on legs and placed against walls and which can be readily moved for cleaning will not be required to be sealed to adjacent surfaces (i.e. work tables and some equipment tables).

### **Exposed Utility Lines**

Utility service lines and pipes shall not be unnecessarily exposed on walls or ceilings, in walk-in refrigeration units, food preparation areas, equipment washing areas, utensil washing areas, toilet rooms, and vestibules. Exposed utility service lines and pipes shall be installed in a way that does not obstruct or prevent cleaning of the floors, walls, and ceilings. Installation of exposed horizontal utility lines and pipes on the floor is prohibited. Installation of exposed utility line and pipes for service to equipment up to point of attachment should be 6 inches above the floor and 1 inch off the wall.

The North Carolina Electrical Code prohibits placement of equipment within 36 inches in front of the electrical panel. It is desirable that switch boxes electrical control panels, wall mounted electrical cabinets, and etc. is installed out of the cooking or dishwashing areas. Consult with you local electrical inspector for more details.

All utility and service lines and openings through the floor must be sealed adequately. Exposed vertical and horizontal pipes and lines must be kept to a minimum. The installation of exposed horizontal utility lines and pipes on the floor is prohibited. Any insulation material used on utility pipes or lines in the food preparation or dishwashing area must be smooth non-absorbent and easy to clean.

## **Sneeze Guard Installation**

1. Sneeze Guards (food Shields): Display of unpackaged foods shall be effectively shielded to intercept the direct line between the customer's mouth and the display of food, and shall be designed to minimize contamination by the customer.
2. Shields shall be mounted to intercept a direct line between the customer's mouth and the food display area at the customer –use- position. The vertical distance from the average customer's mouth to the floor shall be considered (1.4 m) 4 ft 6 in to (1.5 m) 5 ft. Special consideration must be given to the average customer's mouth height in educational facilities and other special installations.
3. Shields shall be fabricated of easy-to-clean and sanitary material.
4. Edges of glass or other hazardous material shall be trimmed with a smooth protective member or have a safety edge of parent material.
5. Where the ends of equipment are designed to allow for customer self service, or customer view food shields complying with these standards shall be installed.

**See Appendix A - 6 Sneeze Guard Design And Installation For Elementary, Middle, High School And For Commercial Food Service Establishments.**

## **SECTION 7 - DISHWASHING FACILITIES**

### **Hand Dishwashing Facilities**

Hand dishwashing facilities should include an approved three-compartment sink. The sink shall be of sufficient size and depth to submerge, wash, rinse and sanitize all utensils. The sinks shall have splashback protection and drainboards that are an integral part and continuous with the sink. Minimum recommended dimensions are as follows:

**Food Stand:** 18" width x 21" length x 14" depth with 24" drainboards; facilities with only self-serve hot-dog may use 18" drainboards.

**Restaurant:** 18" width x 21" length x 14" depth with 36" drainboards, if single-service restaurant or restaurants utilizes multi-use utensils or has 50 or less seats, 24" drainboards are acceptable. Establishments with more than 50 seats should have pre-flush or pre-scrapping equipment should be provided.

If additional holding space for soiled utensils is required, this may be accomplished by storage carts.

Adequate facilities shall be provided to air-dry utensils. This may be accomplished by approved drainboards, dishtables, portable or stationary air drying racks, or wall and/or overhead shelving units located in close proximity to the dishwashing area. Floor drains should be provided in areas where wet pots, utensils and equipment are air-drying on approved racks or dish tables away from the sink. **(Figure #11 illustrates effective methods of air drying utensils.)**



**Figure #11**

## **Mechanical Dishwashing**

Full service facilities that utilize multi-use eating and drinking utensils and seat in excess of 100 people and facilities with 50 seats that utilize self service buffet units should provide mechanical dishwashing facilities. The capacity of the dishwashing machines shall be based on the peak number and type of dishes, utensils, flatware, etc. that must be washed each hour.

The following formula offers the minimum acceptable method for determining the required rack capacity per hour; seating turnover is assumed to 1.5 times per meal and a minimum of 5 pieces of tableware are assumed for each place setting.

### **Formula for a 100 seat food service facility:**

$$100(\text{seats}) \times 1.5(\text{seat turnovers per hour}) = 150 \times 5(\text{utensils per place setting}) = 750$$

$$750(\text{utensils used per hour}) / 20(\text{utensils per rack}) = (\text{required \# racks per hour})$$

OR

$$100 \times 1.5 = 150 \times 5 = 750 / 20 = 37$$

For this example a dishwashing machine rated by the manufacturer to wash a minimum of 37 racks per hour must be provided. Consult the manufacturers specification sheets for optimum capacity.

An adequate facility for preflushing or prescrapping shall be provided on the soiled dish side of the Dishwashing machine. The facility shall comply with the standards of NSF or equivalent.

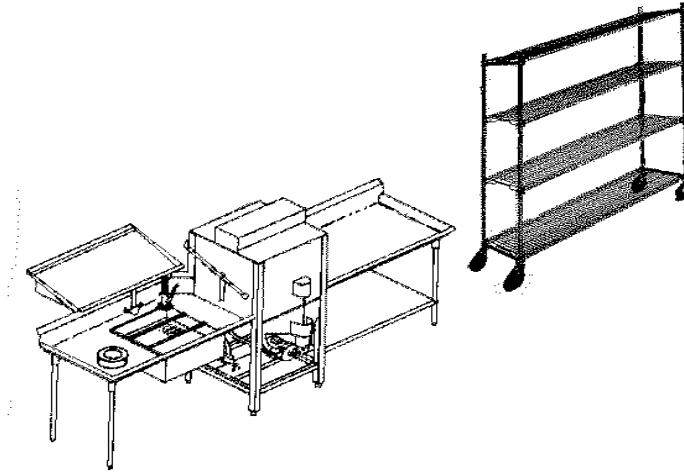
The requirements for air-drying shall be the same as for hand dishwashing. Where low-temperature dishmachines are used, additional drying space may be required.

Dishwashing facilities are recommended to be located such that dirty dishes from the dining area are not carried through food preparation, storage or display area. Dishwashing equipment should be located immediately inside the kitchen door when entering from the dining area. This location will reduce the possibility of contamination that can occur when dirty dishes are transported through the kitchen and food preparation areas.

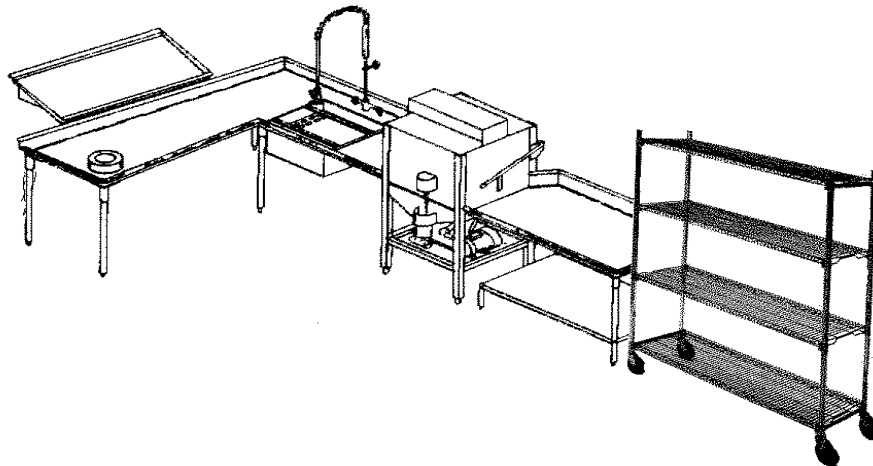
Adequate facilities shall be provided to air-dry utensils prior to final storage. This may be accomplished by approved drainboards, dishtables, portable or stationary air drying racks, or wall and/or overhead shelving units located in close proximity to the dishwashing area. Floor drains should be provided in areas where wet pots, utensils and equipment are air-drying on approved racks or dish tables away from the sink. For air drying of utensils it not necessary to have large drainboards.

Drainboards that are large enough to handle two to three racks of dishes depending on the capacity of the dishmachine used in conjunction with portable wire racks for final air drying of utensils will provide a greater area available for final air drying than with larger drainboards.

(Figure #12 & 13 Illustrates effective methods of air drying utensils prior to storage.)



**Figure 12**



**Figure 13**

### **Installation Requirements**

Dishwashing equipment must be installed so the equipment and any adjacent equipment or areas are readily accessible for cleaning, eliminates the potential for cross-contamination and does not create a vermin harborage.

## **SECTION 8 - DETERMINING HOT WATER SUPPLY REQUIREMENTS**

The Food Service Advisory Committee has developed a uniform guideline for the sizing of hot water heaters for food service establishments. This guideline is used to insure uniformity on sizing of water heaters throughout the state and to insure food service establishments are provided with sufficient hot water for all operations.

### **The hot water heater should be sized as follows:**

1. The minimum storage capacity for any establishment should be 50 gallons.
2. Hot water recovery is based on fixture requirements in accordance with Table #1.
3. A 100% degree-rise in temperature is used in calculating hot water recovery.
4. See notes #4 on following page for calculating sink (GPH) gallons per hour.

Note #1	Dishwasher (____ gals/hr. FINAL RINSE x 70%)
Note #2	Cloth Washer Calculation  A. Limited Use/Cloth washer used one to two times per day; beginning or ending of day operation GPH = 60 GPH x 25%.  B. Intermediate Use/Cloth washer used three to four times per day; GPH = 60 GPH x 45%.  C. Heavy Use/Cloth washer used once every two hours; GPH = 60 GPH x 80%.  D. Continuous Use/Cloth washer used every hour; GPH = 60 GPH x 100%.
Note #3	Hose reels @ 20 GPH for first reel & 10 GPH for each additional reel.
Note #4 - GPH Requirements for sink	$\text{GPH} = \left( \frac{\text{Sink size in cu.in.} \times 7.5 \text{ gal./cu.ft.} \times \# \text{ compartments} \times .75 \text{ capacity}}{1,728 \text{ cu.in./cu.ft.}} \right)$
Short version for above	$\text{GPH} = \text{Sink size in cu. in.} \times \# \text{ compartments} \times .003255/\text{cu. in.}$ <p>Example 24"x 24"x 14" x 3 compartments x .003255 = 79 GPH</p>
Water heater storage capacity. (____ Gallons Storage)	
Water heater recovery rate in gallons per hour at a 100°F temperature Rise. (____Gallons per hour)	

\*\*\*\*\*

XIII. Hot Water Heater Size And Capacity						
HOT WATER HEATER CALCULATION WORKSHEET						
EQUIPMENT	QUANTITY	TIMES	SIZE	EQUALS	GPH	
			(in inches)			
One-comp. sink See note #4		X	__by__by__	=		
Two-comp. sink See note #4		X	__by__by__	=		
Three-comp. sink See note #4		X	__by__by__	=		
Four-comp. sink See note #4		X	__by__by__	=		
One-comp Prep sink		X	5 GPH	=		
Two-comp Prep sink		X	10 GPH	=		
Three-comp Prep sink		X	15 GPH	=		
Three comp. bar sink See note #4		X	__by__by__	=		
Four comp. bar sink		X	__by__by__	=		
Hand sink		X	5 GPH	=		
Pre-rinse		X	45 GPH	=		
Can wash		X	10 GPH	=		
Mop sink		X	5 GPH	=		
**Dishmachine		X	Note #1	=		
**Cloth Washer		X	Note #2	=		
**Hose reels		X	Note #3	=		
Other equipment		X		=		
Other equipment		X		=		
Other equipment		X		=		
Total 140 F GPH (gallons per hour) Recovery Requirements					Total =>	
Note - 140° F Hot water heaters are to be sized at the 140° F GPH recovery required at a temperature rise of 100° F.						

## SAMPLE CALCULATION

XIII. Hot Water Heater Size And Capacity					
HOT WATER HEATER CALCULATION WORKSHEET					
EQUIPMENT	QUANTITY	TIMES	SIZE	EQUALS	GPH
			(in inches)		
Three -comp. sink See note #4	1	X	24" by 24" by 24"	=	79
Two-comp Prep sink	2	X	10 GPH	=	20
Hand sink	5	X	5 GPH	=	25
Pre-rinse	1	X	45 GPH	=	45
Can wash	1	X	10 GPH	=	10
Mop sink	1	X	5 GPH	=	5
**Dishmachine	1	X	Note #1	=	52
**Cloth Washer	1	X	Note #2	=	27
**Hose reels	2	X	Note #3	=	30
Total 140 F GPH (gallons per hour) Recovery Requirements				Total ==>	293

**Note #1** - Dishmachine - Hobart AM-14 Final Rinse GPH = 74  
Using Note #1 - 74 gal/hr Final Rinse x .70% = 51.8(= 52 GPH)

**Note #2** - Cloth Washer used 4 times per day = 60 gal x 45% = 27 GP

## **SECTION 9 - FINISH SCHEDULE**

### **FLOORS**

1. All floor coverings in food preparation, food storage, utensil-washing areas, walk-in refrigeration units, dressing rooms, locker rooms, toilet rooms shall be smooth, non-absorbent, easily cleanable and durable. Anti-slip floor material should be used in traffic areas.
2. Any alternate materials not listed in the below chart must be submitted for evaluation.
3. Joints between floors and walls shall be coved or radiused with appropriate materials.
4. Properly installed floor drains should be provided in floors that are subject to water splash from sinks, basins or equipment. Floors shall be sloped to the drain.
5. Grouting shall be non-absorbent and impregnated with epoxy, silicone or polyurethane.
6. All walk-in refrigeration units should be installed according to the NSF guide "Special Consideration Regarding Installation of Walk-In Refrigerators and Storage Freezers" or equivalent.
7. Carpet is not recommended in the immediate area adjacent to the buffet units.
8. Sealed concrete and commercial grade vinyl composition tile may be used on floors. However, their applications are limited.

### **WALLS**

1. The walls, including non-supporting partitions, wall coverings and ceilings of walk-in refrigerating units, food preparation areas, equipment washing and utensil washing areas and toilet rooms shall be smooth, non-absorbent and easily cleanable. Light colors are recommended for walls and ceilings. Exposed studs, joists and rafters are not considered acceptable wall finishes.
2. All alternate materials not listed in the above chart must be submitted for evaluation.
3. Glazed surfaces include glazed block or brick or ceramic tile. Grouting must be non-absorbent and impregnated with epoxy, silicone, polyurethane or an equivalent compound. Concrete block if used must be rendered non-porous and smooth by the application of an approved block filler followed by the application of an approved paint or other approved material.

All mortar joints should be tooled and finished to render them easily cleanable.

4. Plastic laminate panels may be used. Joint finishes shall be smooth and compatible with the wall finish.

5. FRP and plastic laminated panel is not recommended behind heat radiating equipment such as fryers, griddles, ranges etc..
6. Finished drywall is not recommended behind utensil wash equipment, can wash, mop sink areas or behind prep sinks.

## **CEILINGS**

Finishes should be light-colored, and must be smooth, non-absorbent and easily cleanable. Vinyl faced drop-in ceiling tile or drywall finished with epoxy paint are considered approved materials for installation in kitchen and food service areas.

\*\*\*\*\*

**The following chart and footnotes provide acceptable finishes for floors, walls and ceilings, by area:**

<b>LOCATION</b>	<b>FLOOR</b>	<b>WALL</b>	<b>CEILING</b>
<b>KITCHEN COOKING</b>	Quarry tile, poured seamless.	Stainless steel, aluminum, fiberglass reinforced panels (FRP), tile	Fiberboard plastic coated, metal clad, dry-wall with epoxy, glazed surface, plastic laminate, vinyl coated gypsum board ceiling tiles.  FRP, acoustical ceiling tile
<b>FOOD PREP &amp; DISHWASHING</b>	Same as above	Same as above, plus approved wall panels, drywall taped and epoxy painted, block filled smooth and tile.	Same as above
<b>SERVING</b>	Same as above	Same as above	Same as above
<b>TOILET ROOM</b>	Quarry tile, vinyl composite tile (VCT)	Same as above	Same as above
<b>JANITOR CLOSET</b>	Quarry tile, poured concrete, VCT	Same as above	Same as above
<b>WALK-INS</b>	Quarry tile, stainless steel, poured sealed concrete.	Aluminum, stainless steel, fiber glass	Aluminum Stainless steel, fiberglass
<b>DRY STORAGE</b>	Same as above plus sealed concrete, commercial grade vinyl composition tile.	Same as above	Same as above
<b>REMOTE BULK STORAGE</b>	Concrete.	Cleanable surface.	Cleanable surface.

## **SECTION 10 - TOILET FACILITIES**

Toilet facilities shall be conveniently located and shall be accessible to employees at all times. They shall be easily cleanable.

Toilet facilities shall be installed according to **The North Carolina State Building Code, Volume II - Plumbing Code**. Consult with the building inspection department for more information and details.

As referenced by the North Carolina State Plumbing Code. Chapter P4 - **Plumbing Fixtures, Section P404 LOCATION OF FIXTURES, Paragraph P404.2 IMPROPER LOCATION:** Piping, fixtures, or equipment shall not be located in such a manner as to interfere with the normal operation of windows, doors, or other exit openings. Toilet rooms shall not open directly into a room used for the preparation of food for service to the public.

As referenced by the North Carolina State Plumbing Code. Chapter P4 - **Plumbing Fixtures, Section P407 MINIMUM FACILITIES, Paragraph P407.2.2** Every building and each subdivision thereof intended for public use shall be provided with facilities in accordance with this chapter. Required facilities shall be directly accessible to the public through direct openings or corridors from the area or areas they are intended to serve. Required facilities shall be free and designated by legible signs for each sex. Pay facilities may be installed when in excess of the required minimum facilities.

Toilet facilities shall be conveniently located, under control of the management, and readily accessible at all times. Toilets that are within 200 feet and on the same floor level of the facility is generally considered to be convenient.

## **SECTION 11 PLUMBING AND CROSS CONNECTION CONTROL DRAINS**

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## **I. PLUMBING SYSTEMS**

Once a potable water system (also referred to as "safe drinking water" or just "drinking water") has been contaminated by the inadvertent actions of the user or installer, the foreign or toxic material can be distributed throughout the facility's potable plumbing system and adjacent premises on the same supply. The contaminated water, if undetected and utilized, may subsequently cause illness or death. Therefore each business, institution, residence, or other user has the ultimate responsibility to protect its potable water from any actual or potential introduction of contaminants or pollutants. The entire piping network for a water system, from the point of origin to the point of use, is divided into two categories: PRIMARY (containment) and SECONDARY (isolation) systems.

### **PRIMARY SYSTEM or CONTAINMENT**

The primary system is composed of the water mains used by the water purveyor to deliver water to the various buildings (or service connections) on the system. The water purveyor is responsible for delivering safe drinking water to the point of delivery for the customer's or users water system (secondary system). To protect the system from foreign or toxic materials being introduced via the customer, a backflow prevention assembly or device is installed at the water service entrance for "containment" on the premises.

### **SECONDARY SYSTEM or ISOLATION**

The secondary system is the plumbing network that distributes potable water from the down stream side of the water meter or service connection to the points of use throughout the facility and/or premises. Remember that few people are aware of what is occurring inside the building and/or premises (secondary system). The determination of cross-connections is, in part, the function of the inspector; however, it is the ultimate responsibility of the owner to comply with state and local plumbing codes specific for that jurisdiction. Safeguarding the system is met by "isolation," providing backflow protection at each actual or potential cross-connection on the premises.

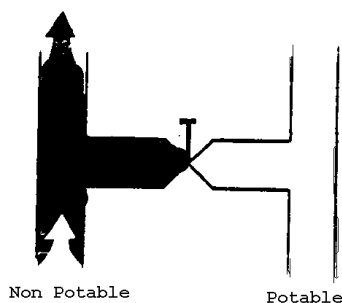
## **II. CROSS CONNECTIONS**

A cross-connection is an ACTUAL or POTENTIAL link between the potable water supply and a source of contamination (sewage, chemicals, gas, etc.). This link can be envisioned as a conduit or hose permitting the transfer of foreign material into a safe drinking water system. A cross-connection can be any temporary or permanent direct connection (hard plumbed), bypass arrangement, jumper connection, removable section, swivel or change over device, etc. that could connect a potable system to a non-potable source. Ideally, it is best not to have any cross-connections, but in certain situations they may be unavoidable. When an installation requires a cross-connection (as a last resort or unavoidable situation i.e., boiler, injector units, chemical aspirators), it must be properly protected with an acceptable backflow prevention assembly or device to eliminate any potential for a reverse flow back into the potable supply. Unprotected cross-connection threatens the health and safety of individuals and food or beverage products utilizing water from that system.

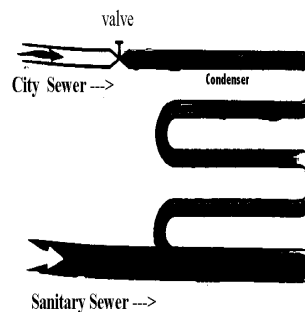
## TWO TYPES OF CROSS-CONNECTIONS

**1. DIRECT CONNECTION:** Direct connections are a physical connection between a potable and non-potable system. An example of this would be a water supply line connected directly to a boiler, sewage line, or other nonpotable auxiliary water source. A direct pathway exists between the two separate systems for contamination to be transferred into the potable system as shown in the diagrams below. A direct connection is subject to both back-siphonage and backpressure (see next page).

**Valved connection between potable water and nonpotable fluid.**

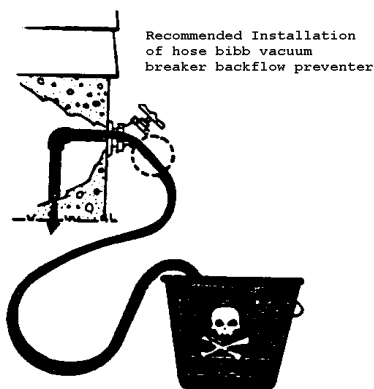


**Valved connection between Potable water and sanitary sewer.**

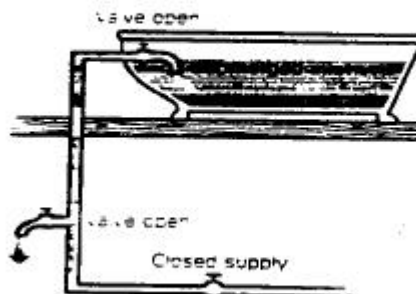


**2. INDIRECT CONNECTION:** An indirect connection between a potable and nonpotable supply does not exist under "normal" conditions; however, under "unique" circumstances a pathway for contamination can occur. Usually the source of contamination may back-up, be blown across, siphoned, pushed or diverted into a potable water supply. An indirect connection is only subject to backsiphonage (see next page).

Example scenario, the end of a faucet terminates below the flood level of a sink, (referred to as a "submerged inlet" because it does not provide the required air gap), and the waste backs up or the sink becomes clogged to the point that the water inlet becomes submerged. If a vacuum or negative pressure should develop in the potable supply, the contaminant could be siphoned into the water supply.



**Backsiphonage in a plumbing system.**



### III. FORCES ACTING ON CROSS-CONNECTIONS

Some cross-connections are immediately obvious, but others can be subtle and difficult to find. Contamination or pollution occurs when the pressure differentials between the water supply and another system, via some connection, are sufficient to transfer the contaminant or pollutant into the potable supply. The temporary reversal of pressures or momentary vacuums in the water supplies can be freakish and unpredictable. These hydraulic forces can either **PUSH** (forced by higher pressure than the potable supply) or **Pull** (vacuum/siphon, the potable supply drops below normal levels) the contaminant into the drinking water system.

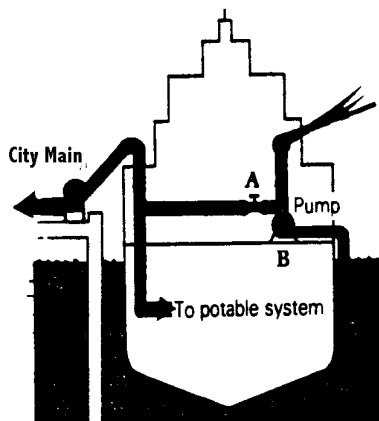
#### BACKFLOW

Backflow is a reverse flow in the primary or secondary system that is opposite to the expected or intended direction. This flow reversal is undesirable; however, a properly protected system can remain safe. There are two types of backflow, acting separately or in combination, that allow contaminates (high hazard) or pollutants (low hazard) to enter the water supply via a cross connection: BACKPRESSURE and BACK-SIPHONAGE.

**BACKPRESSURE** (A PUSHING FORCE) Backpressure occurs when both systems (potable & nonpotable) are under pressure (above atmospheric pressure or positive head pressure), but the nonpotable system has a greater pressure than the potable system. This pressure differential pushes the contaminant or pollutant into the potable supply. Pumps or thermal expansion from boilers connected to a supply are examples of how these pressure differentials can be created.

#### PRINCIPLE CAUSES OF BACKPRESSURE:

For backpressure to occur, a "direct connection" to another system **must** exist. This other system would actually or potentially be operated at a higher pressure than the potable supply, i.e., a fertilizer injector system, booster pump, boiler, fire sprinkler system or other auxiliary water source.



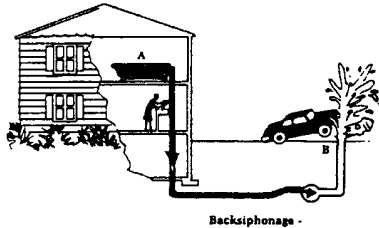
#### Potential Backpressure on City Supply

**A. Contact Point:** A valve connection exists between the potable and the nonpotable systems aboard the ship.

**B. Cause of Reversed Flow:** While the ship is connected to the city water supply system for the purpose of taking on water for the potable system, the valve between the potable and nonpotable systems is opened, permitting contaminated water to be pumped into the municipal supply.

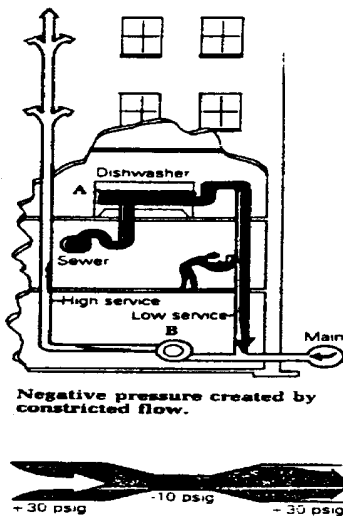
**BACK-SIPHONAGE (VACUUM, PULLING FORCE)** Back-siphonage occurs when the pressure in the water supply drops below zero (less than atmospheric pressure or negative head pressure), and the adjacent nonpotable source is drawn or siphoned into the potable supply.

NOTE: Back-siphonage can occur with either a "direct" or "indirect" connection, or the systems can be "opened" or "closed" - meaning exposed/open to the atmosphere, or not exposed/closed to the atmosphere.



#### Backsiphonage

- A. **Contact point:** There is a submerged inlet in the second floor bathtub.
- B. **Cause of Reversed Flow:** An automobile breaks a nearby fire hydrant causing a rush of water and negative pressure in the service line to the house sucking dirty water out of the bathtub.
- C. **Suggested Correction:** The hot and cold water inlets to the bathtub should be above the rim of the tub.



#### Backsiphonage

- A. **Contact Point:** The water supply in the dishwasher is not protected by a vacuum breaker. Also, the dishwasher has a solid waste connection to the sewer.
- B. **Cause of Reversed Flow:** The undersized main serving the building is subject to reduced pressure and therefore only the first two floors of the building are supplied directly with city water pressure. The upper floors are served with a booster pump drawing suction directly from the water service line. During periods of low city pressure the booster pump suction creates negative pressure in the low system thereby reversing the flow.
- C. **Suggested Correction:** The dishwasher hot and cold water should be supplied through an airgap and the waste from the dishwasher should be discharged through an indirect waste line. The booster pump should be equipped with a low-pressure cutoff device.

### PRINCIPLE CAUSES OF BACK-SIPHONAGE:

1. Undersized sections of pipe can create an aspirator effect in the restricted area.
2. A break or repair in a supply line can create a vacuum or siphoning effect (as gravity drains the water out) on the elevated portions of the system above the effected area.
3. A high water withdrawal, such as fire fighting or water main flushing, can create a vacuum. This withdrawal is more likely to create stronger negative pressures at the higher elevations on the system.
4. A vacuum can be induced on the suction side of a booster pump, such as high-rise buildings and processing plants.

## **IV. EVALUATING CROSS-CONNECTIONS**

There are several different types of assemblies (units that can be tested after installation) and devices (can not be tested after installation) available for controlling cross-connections and preventing backflow. The type of assembly or device needed depends upon the type of cross connection, the intended purpose of the plumbing configuration, and what could backflow into the water supply under various scenarios.

### **EVALUATING EXISTING OR POTENTIAL CROSS-CONNECTIONS:**

1. Evaluate the plumbing supply, equipment attached to it, and any waste lines attached or near by. Think about **WHAT COULD GO WRONG** with this design and **WHAT CAN BE DONE TO MAKE IT SAFE.**
2. Determine the **DEGREE OF HAZARD INVOLVED**, either a **HIGH** or **LOW** hazard will exist with a cross-connection. The degree of hazard depends on whether the nonpotable source is deleterious or not.

**HIGH HAZARD** situations exist when there is an actual or potential connection for any toxic or infectious substance (also referred to as a **CONTAMINATION**), to be introduced into the water supply, and may create a danger to the health and well-being of anyone using the water. Examples of contaminants are pesticides, chemicals, and infectious microorganisms.

**LOW HAZARD** situations exist when there is an actual or potential connection for a nontoxic substance (also referred to as a **POLLUTANT**) to be introduced to the water supply and create a nuisance, or be aesthetically objectionable to the water user. Examples of pollutants are turbidity, beverages, and food coloring.

3. Evaluate the use of the backflow prevention device relative to the **TIME** that supply pressure is present on both the "up stream" and "down stream" side of the device.

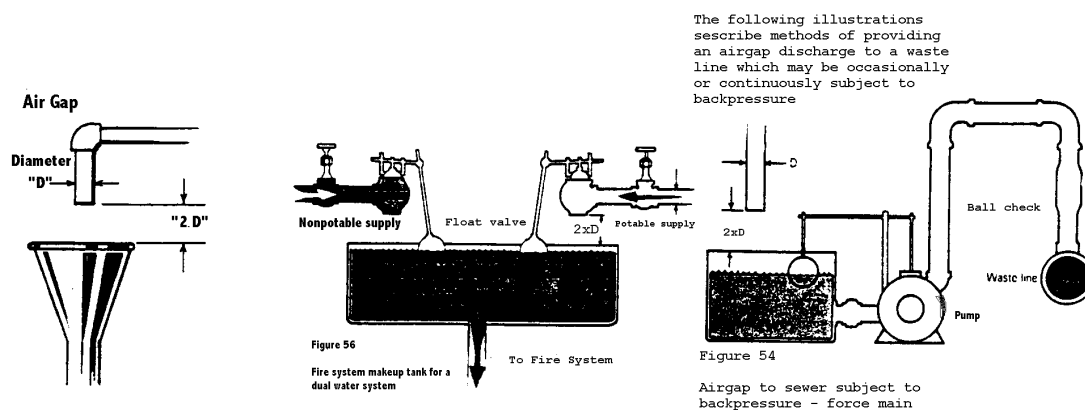
**CONTINUOUS PRESSURE** conditions exist when the water pressure remains on both sides of the device for more than 12 hours. Continuous water pressure can exist under **DYNAMIC** conditions (the water is "on" and flowing in the intended direction through the device) or **STATIC** conditions (the water is "on" but a shut off device down stream in the "off" or closed position results in no flow through the device).

**NON-CONTINUOUS PRESSURE** conditions exist when the device is only subject to intermittent water pressure on both sides of the device that does not exceed 12 hours.

Note: Continuous and non-continuous pressure conditions are important factors in determining the installation and use of backflow prevention devices.

## V. PHYSICAL BACKFLOW PREVENTION METHODS

**AIR GAP** or **PHYSICAL AIR GAP** (an "air break" is in reference to waste lines only): An air gap is the **MOST DESIRABLE METHOD OF BACKFLOW PREVENTION**. It is simple, economical, non-mechanical (no moving parts), fail safe, and can be used for potential back-siphonage or backpressure situations. An air gap is an unobstructed, vertical air space that separates a potable system from a nonpotable system. This air gap is necessary to prevent any contaminant or pollutant from being siphoned or pushed back into the potable water supply. Although this is an extremely effective backflow preventer, the interruption in the piping creates a subsequent pressure drop on the "down stream" portion. Consequently, most air gaps are used at the end of the supply line or faucet such as at a sink, vat or storage tank.



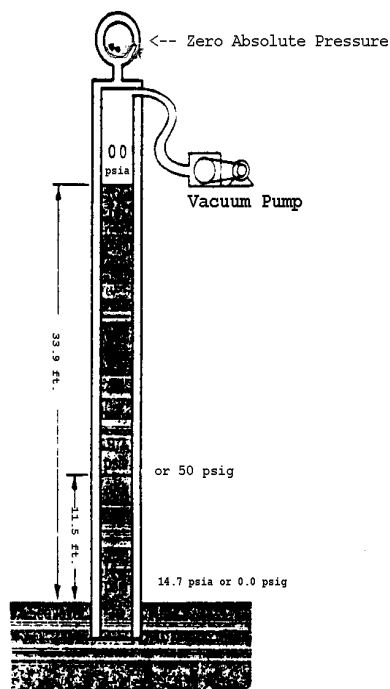
### **AIR GAP INSTALLATION & USE:**

1. The air gap must be the greater of the two - **A MINIMUM OF ONE INCH OR TWICE THE INSIDE DIAMETER OF THE SUPPLY PIPE**. This distance is measured from the supply pipe to the flood level rim (the point of over flow) of the receptacle or fixture.
2. Air gaps require inspection for any compromised "2xD or 1 inch" requirements and any splashing problems, but no testing is necessary.
3. An air gap can be installed in a continuous piping system to protect the source from any potential contaminant on the down stream side of the system. Providing an air gap within the supply system (versus at the end of the supply line) would require a reservoir and possibly a booster pump. An open reservoir can subject the water to air borne pollutants and the loss of free chlorine in a treated supply. If a reservoir is utilized, then there needs to be a means to periodically drain and clean the tank.

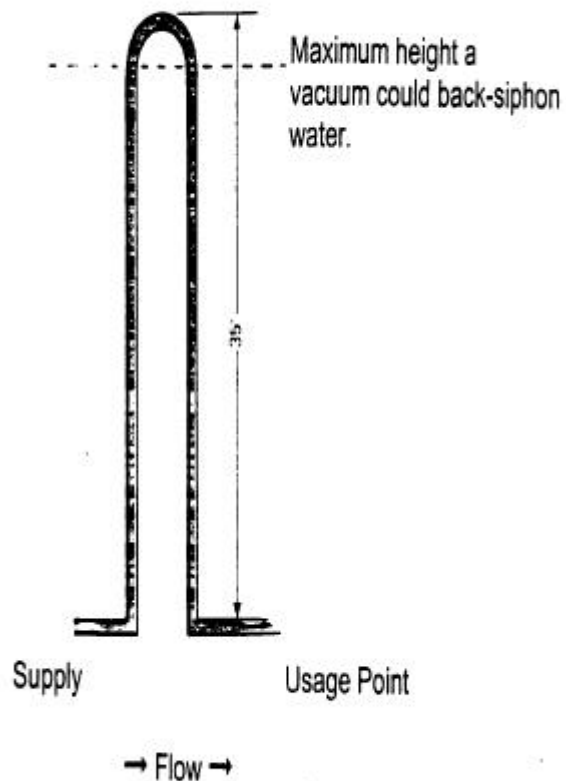
## **BAROMETRIC LOOP**

The barometric loop is an extension of the supply line that can be construed as a giant upside down "U". This configuration is designed based on the fluid dynamics of water and is utilized to protect all down stream inlets against "back-siphonage" **only**. An absolute vacuum on a pipe can only "pull" the water up 33.9 feet; to go any higher, a pump would be necessary to push the water up the column. The barometric loop must be at least 35 feet tall and the base must be at a higher elevation than any of the inlets or fixtures that are on the down stream side of the loop. The size of the 35-foot high loop limits its practicality for application (processing plant) for protecting against negative pressure.

Effect of evacuating air from a column.



Barometric Loop



### **BAROMETRIC INSTALLATION & USE:**

1. The loop must be at least 35 feet upright and all plumping inlets or fixtures must be no higher than the loop's base.
2. Approved for CONTINUOUS PRESSURE & NO POTENTIAL backpressure

## **VI. MECHANICAL BACKFLOW ASSEMBLIES & DEVICES**

The type of mechanical assembly or device selected must be appropriate for the degree of hazard and specific application relevant to the potential backflow possibilities. Mechanical backflow preventers consist of single or multiple check valves that open from the flow pressure of the potable water. These valves are fabricated to seat tightly on a machined surface and when closed, prevent any flow in the wrong direction. Also, some devices have air inlets or ports that are vented to the atmosphere to relieve any vacuum or negative pressure developed in the system. All backflow devices must be installed so they are accessible for inspection, service and repair.

### **NOTE:**

**The specific use and installation of a backflow prevention assembly or device must be clarified by the manufacturer and comply with the plumbing codes governing the jurisdiction in which the unit is installed.**

## **AMERICAN SOCIETY OF SANITARY ENGINEERING (ASSE)**

ASSE is a consensus, voluntary ANSI (American National Standards Institute) accredited association that develops and maintains product performance standards for component parts of the plumbing systems and professional qualification standards. Eighteen standards are for backflow devices/assemblies. On the following pages, examples of various devices are cited with the number for the ASSE standard under "Installation & Use."

## **FOOD PROCESSING & RETAIL FOOD CODE PLUMBING REGULATIONS**

### **FDA Food Code**

Chapter 5. The following section is from the Food and Drug Administration's 1997 Food Code (Food establishments) pertaining to: 5-202.14 Backflow Prevention Device, Design Standard.

A backflow or backsiphonage prevention device installed on a water supply system shall meet American Society of Sanitary Engineering (A.S.S.E.) Standards for construction, installation, maintenance, inspection, and testing for that specific application and type of device.

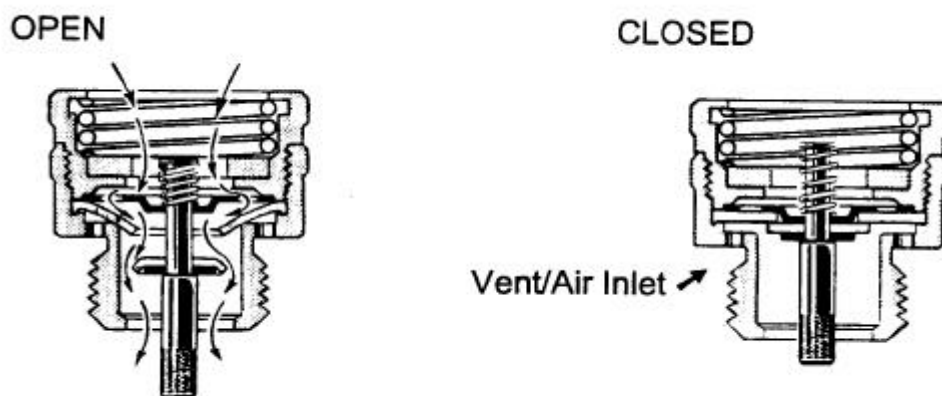
### **Grade A Pasteurized Milk Ordinance** (PMO), Current Edition

Item 8r, 7p, -and Appendix -D, Standards for Water Sources.

**National Shellfish Sanitation Program Manual of Operations, Part II** 1995 Revision  
Section D, Part 8 and 9.

## **HOSE BIBB VACUUM BREAKER (HBVB)**

A hose bibb vacuum breaker contains one spring loaded valve and an atmospheric vent that is controlled by a diaphragm seal. The HBVB is installed on the end of a hose bibb (sill cock or boiler drain inlet) for a garden hose, slop/mop sink hose etc., or anywhere else a hose can be connected. Internally, the valve is spring loaded to be in a closed position and opens with flow in the proper direction. As the water flow begins (dynamic, water flow in the desired direction), the valve opens and allows the diaphragm seal to close off the atmospheric vent (the flow pressure is what moves & holds the diaphragm against the vent ports). When zero pressure or back-siphonage (negative pressure) conditions exist, the spring pulls the valve closed and simultaneously pushes the diaphragm (thus, opening the vent to relieve any vacuum) into position to form a tight seal between the valve and valve seat. Under static conditions (no flow) with the HBVB, the check valve may or may not be closed. (The HBVB is not approved for continuous pressure but there may be time periods when water pressure exists on both sides of the device)



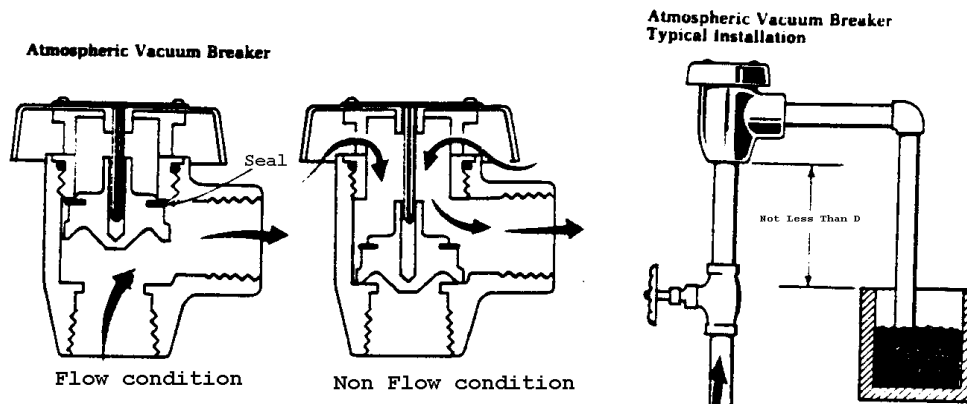
### **HBVB INSTALLATION & USE:**

1. Shut off valves must be located up stream from the vacuum breaker, and spring-loaded pistol-grip shutoff valves are not to remain on the hose with the water left on, when not being actively used.
2. Each hose connected to a manifold or "Y" must be provided with its own HBVB, i.e., county fair, and special events where several vendors may share one hose spigot
3. Approved for **HIGH HAZARDS, NON-CONTINUOUS PRESSURE & NO POTENTIAL BACKPRESSURE** ASSE standard #1011

**NOTE-** HBVB's cannot be used under continuous pressure conditions (defined as water pressure on both sides of the unit for more than 12 hours), because the spring loaded valve may stick or freeze in the open position, thus making the water supply vulnerable to backflow. Remember you must evaluate the HBVB in its setting and determine the use and time. If the use period extends over 12 hours, then approved continuous pressure backflow devices must be installed.

## **ATMOSPHERIC VACUUM BREAKER (AVB)**

This device has an internal polyethylene or metal float valve that moves up and down on a shaft (not spring loaded). Water moving in the normal direction of flow lifts the float, and causes the atmospheric vent to close (an opening on the top of the unit is open to the air). The normal water pressure keeps the float valve in the upward closed position. Shutting off the water causes the float to drop; the supply valve to close; and results in the atmospheric vent being open. With the water off, the down stream piping of the AVB is open to the atmosphere, creating an air gap, and thus preventing any back-siphonage. When a negative pressure occurs on the supply side, the float valve drops, closing off the supply, and opening the atmospheric vent. Thus, any down stream contamination will not be siphoned into the potable supply. The atmospheric vacuum breaker provides **excellent protection against "backsiphonage" only**. Exposing the AVB to backpressure can cause the atmospheric valve to modulate up and down, thus permitting a potential contaminant, via backpressure, to enter the water supply.



### **AVB INSTALLATION & USE:**

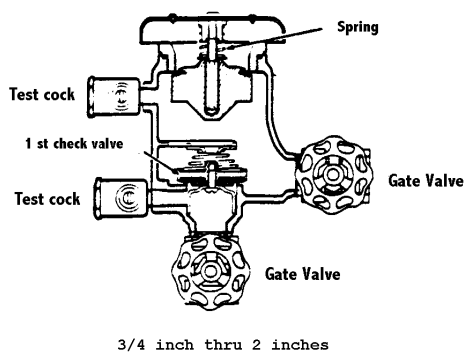
1. The mushroom shaped device must be installed vertically (upright position), with the atmospheric opening at the top and the elevation of the unit must be at least 6 inches above the highest inlet, "down stream" of the AVB.
2. All shutoff devices must be located "up stream" from the AVB (supply side). This unit cannot be tested after installation.
3. Approved for **HIGH HAZARDS, NON-CONTINUOUS PRESSURE & NO POTENTIAL BACKPRESSURE.** ASSE standard #1001

**NOTE:** AVB's cannot be used under continuous pressure conditions (defined as water pressure on both sides of the unit for more than 12 hours), because the float valve may stick or freeze in the up position, thus making the water supply vulnerable to potential backsiphonage. Remember, you must evaluate the AVB in its setting and determine the use and time. If the use period extends over 12 hours, then an approved continuous pressure backflow device must be installed.

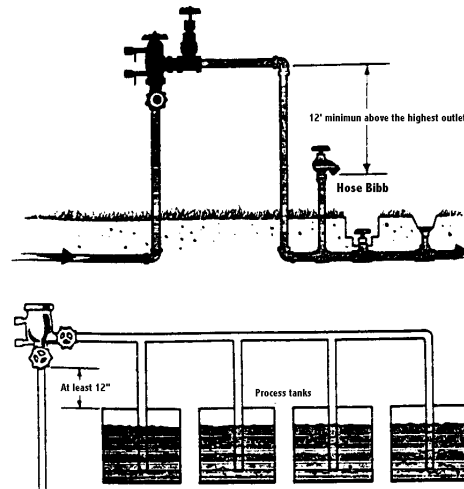
## **PRESSURE VACUUM BREAKER (PVB)**

The PVB is similar to the atmospheric vacuum breaker (AVB), except that it has two test cocks and two gate valves (new units use ball valves) for testing the unit, and it also has two positive seating (spring loaded) valves. The first check valve (supply side) is spring loaded for a closed position and "guards" the potable water supply side; when the water supply is turned on, the flow pushes it in the open position. The second check valve or air inlet valve (down stream side) is spring loaded for an open position to the atmosphere and only closes when the supply water is turned on. When the supply pressure drops to or below atmospheric pressure (below 0 gauge pressure), the second check valve opens to the atmosphere and, the first check valve closes. As with the AVB, the PVB only provides protection for back-siphonage.

Pressure Vacuum Breaker



Typical Agricultural and Industrial Application of Pressure Vacuum Breaker



## **PVB INSTALLATION & USE:**

1. The unit is generally used in agricultural, irrigation, and industrial applications.
2. The PVB must be installed at least 12 inches above the highest elevated inlet or fixture on its down stream side. Also, the unit must have a shut off valve on each side and two test cocks for testing.
3. The device must be located in an accessible area for testing and servicing. Also, it is permissible to install shut off devices down stream of this unit.
4. Lines should be thoroughly flushed prior to installation in order to prevent any debris from lodging in the valve seats and preventing a tight seal.
5. The PVB is approved for **HIGH HAZARD- CONTINUOUS PRESS RE & NO POTENTIAL BACKPRESSURE.** ASSE standard #1020

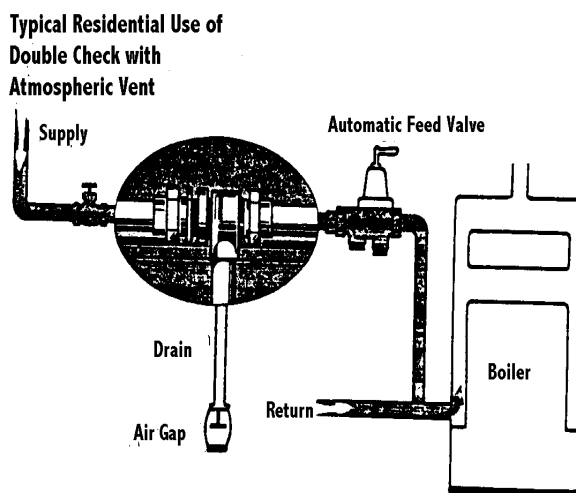
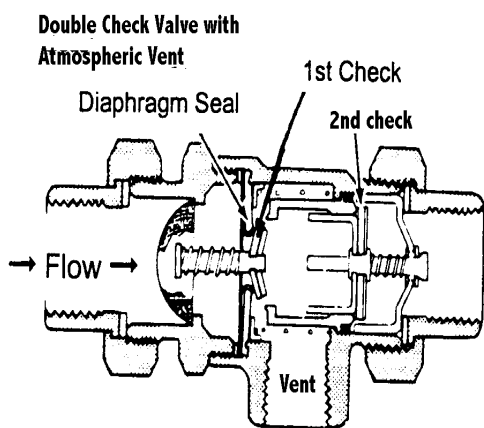
## **BACKFLOW PREVENTERS WITH INTERMEDIATE ATMOSPHERIC VENT**

### **1. SPECIALTY UNITS FOR 1/2 & 3/4 INCH SUPPLY LINES**

This device contains an atmospheric vent between two spring loaded check valves, and these valves are spring loaded for automatic closure under static (no water flow) conditions. The atmospheric vent is controlled by a diaphragm seal that directly responds to the movement of the supply side (primary) check valve. As the water flow begins (dynamic), the primary check opens and simultaneously frees the diaphragm seal to close off the atmospheric vent and then proceeds to open the secondary check valve (down stream side). The positive supply pressure holds the diaphragm seal in place to close off the atmospheric vent under static (there is no flow, but supply pressure exits in the device) or dynamic conditions. Under back-siphonage conditions, the diaphragm seal is able to open the atmospheric vent independent of the primary check valve (to relieve any vacuum on the supply side). To further understand how an atmospheric vent satisfies a vacuum, put a hole in a soda straw, keeping the hole out of the soda and try to drink the soda.

When a zero pressure or back-siphonage condition exists on the supply side, the primary check valve closes under spring pressure and simultaneously pushes the diaphragm seal into position to form a tight seal between the valve and valve seat-opening the atmospheric vent and closing the secondary check valve.

Under backpressure conditions, the secondary check valve would close first. If the secondary check valve were to foul in the closed position, the primary check valve would close and the backpressure leakage would drain out through the atmospheric vent (air break chamber). (Note: Backflow preventers with atmospheric vents should be located so that water leakage will not cause a nuisance.)



**SPECIALTY UNITS WITH AN INTERMEDIATE ATMOSPHERIC VENT FOR    & 3/4  
INCH SUPPLY LINES, continued**

**INSTALLATION & USE:**

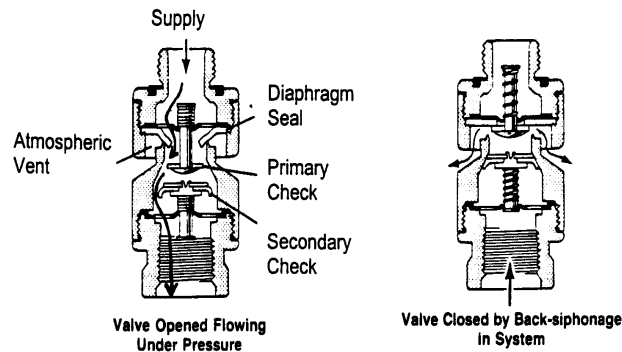
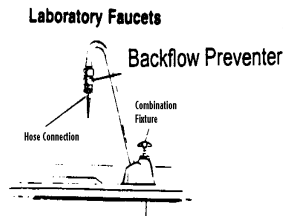
1.     The unit can be installed horizontally or vertically and must not be located in a pit or a location subject to standing water. Under no circumstances should plugging of the relief port or vent be permitted.
2.     Generally, the unit may be installed on water supply lines for laboratory equipment, food processing tanks, sterilizers, dairy equipment, livestock drinking fountains, residential boilers, or in other situations where cross-connection control is needed.
3.     Approved for **LOW HAZARD. CONTINUOUS PRESSURE & BACKPRESSURE OR BACK-SIPHONAGE.**    ASSE standard #1012

Note: Some plumbing codes or jurisdictions place application limitations on this device, because the unit cannot be tested.

## **INTERMEDIATE ATMOSPHERIC VENTS CONTINUED**

### **2. SPECIALTY IN-LINE APPLICATIONS/LAB FAUCETS**

These types of backflow preventers operate on the same principle as the backflow preventer with an intermediate atmospheric vent for 1/2 and 3/4 inch supply lines. There are several types of these units and not all of them are approved for continuous pressure.

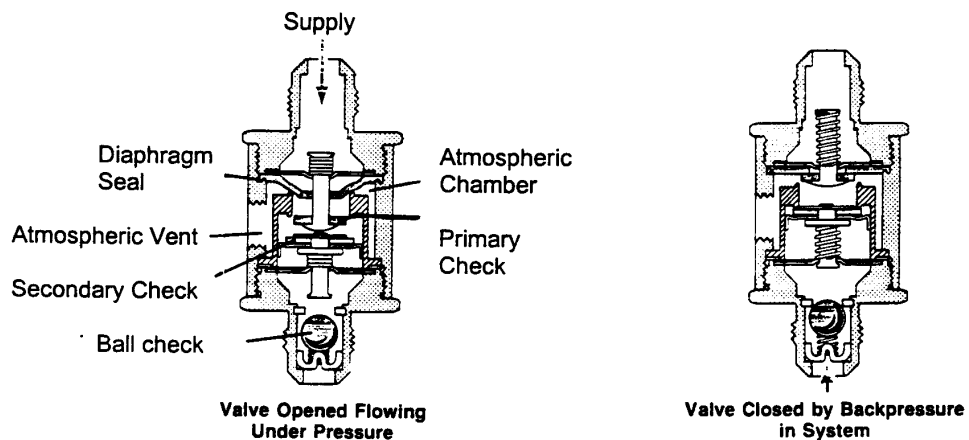
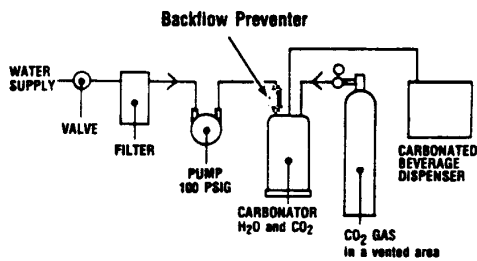


### **INSTALLATION & USE:**

1. Units that are approved for continuous pressure can be used in supply lines for low water volume needs such as coffee and tea urns or icemakers. (Not approved for soda carbonators.)
2. Units that are only approved for non-continuous pressure applications such as those installed on the supply side of an aspirator for a laboratory faucet or on a barber shop/ beauty parlor sink.
3. Whether a particular unit is **APPROVED FOR CONTINUOUS PRESSURE OR NOT WILL NEED TO BE CLARIFIED BY THE MANUFACTURER.**
4. All types are approved for **LOW TO MODERATE HAZARDS AND BACKPRESSURE OR BACK-SIPHONAGE.** ASSE standard #1035

## INTERMEDIATE ATMOSPHERIC VENTS CONTINUED

**3. SPECIALTY UNITS FOR BEVERAGE VENDING MACHINES** This backflow preventer is very similar internally to the specialty units for 1/2 & 3/4 inch, and 1/4 & 3/8 inch supplies, except that it has an added ball check valve (after the secondary check valve). The ball check is an extra precaution to prevent carbon dioxide (CO<sub>2</sub>) from backflowing (via backpressure) out of a soda carbonator and into any copper supply lines. The CO<sub>2</sub> gas reacts with water to form carbonic acid, which in turn will dissolve the copper lines and thus create possible copper toxicities in those ingesting the water. Any carbon dioxide leaking past the ball check valve and the secondary disc valve would be vented into the atmosphere via the atmospheric vent/air inlet.



### **INSTALLATION & USE:**

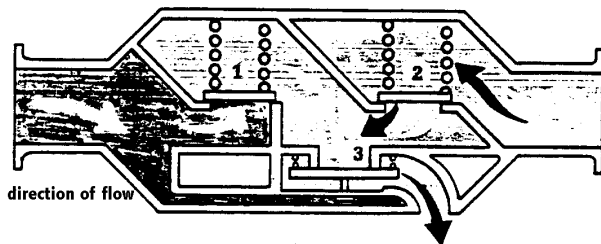
1. The backflow preventer and carbonator system must be located in a well ventilated area. Installation may be horizontal or vertical.
2. The unit may also be used for other beverage equipment such as coffee, tea, and hot chocolate.
3. Approved for **LOW HAZARD- CONTINUOUS PRESSURE & BACKPRESSURE OR BACK-SIPHONAGE.** ASSE standard #1032

## **REDUCED PRESSURE ZONE BACKFLOW PREVENTION ASSEMBLY (RPZ)**

This type of mechanical backflow prevention assembly provides the maximum protection against both back-siphonage and backpressure. Construction of the RPZ consists of two very sensitive, independent, spring loaded check valves with a reduced pressure "zone" between them (at least a 2 psi pressure differential between the "supply pressure" and the "reduced pressure zone"). These check valves are spring loaded to automatically close unless they are held open with flow in the proper direction. As the water passes through the primary check valve, the water pressure will drop (predetermined friction loss/resistance) at least 2 psi in the "reduced" pressure zone or central chamber. Under normal conditions the water will continue through the secondary check valve (only requires 1 psi to open) to the point of usage:

The reduced pressure zone contains a relief valve that drains to the atmosphere and is spring loaded for an automatic open position. The relief valve has the RP zone water pressure on one side and the water supply pressure on the other side. To keep the relief valve closed, the supply pressure must exceed the RP zone pressure. Thus, it will spring open under any conditions causing the water pressure in the "RP zone" to approach or exceed the supply pressure. Also, when the relief valve opens, an air passage from the atmospheric vent to the RP zone is opened to satisfy any back-siphonage conditions. So, even if both check valves are fouled, the relief valve will continue to protect the supply.

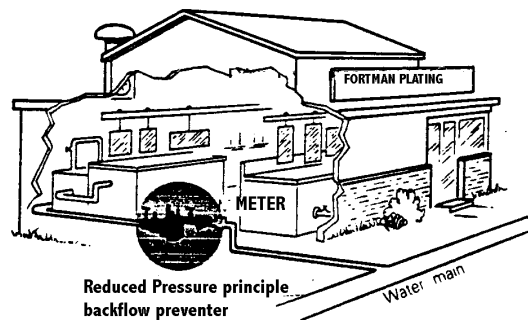
**Reduced Pressure Zone  
Backflow Preventer — Principle  
of Operation**



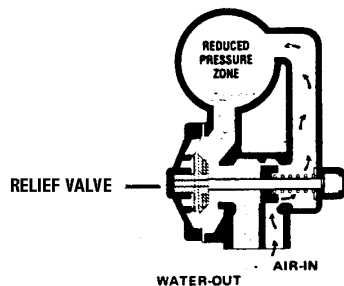
- 1. Primary Check Valve
- 2. Secondary Check Valve

- 3. Relief Valve

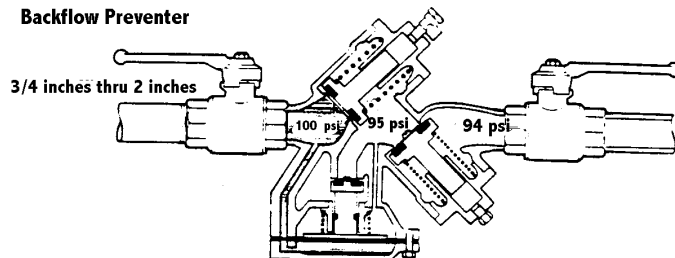
**Plating Plant Installation**



**Reduced Pressure principle  
backflow preventer**

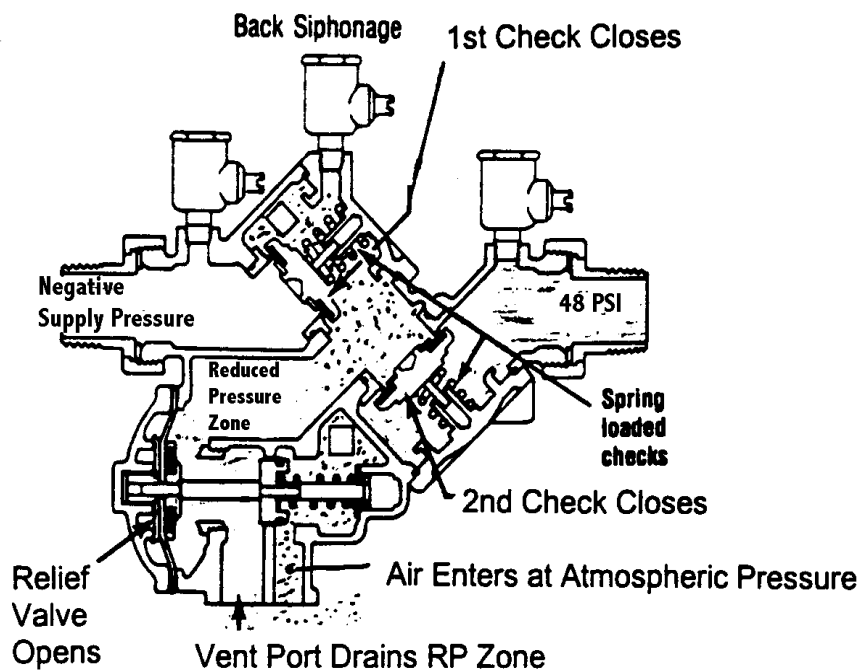


**Reduced Pressure Zone  
Backflow Preventer**



## RPZ WATER FLOW AND RELIEF VALVE ACTION WITH VARIOUS SCENARIOS:

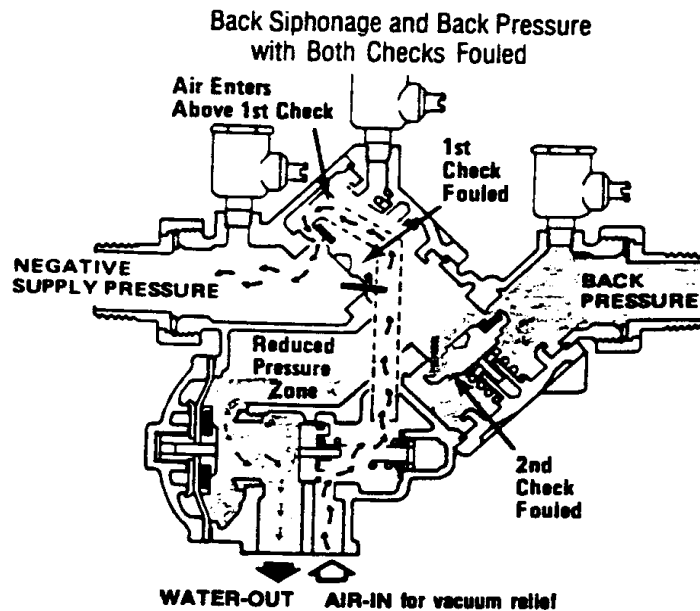
1. **BACKPRESSURE** - pressure increases downstream from the backflow preventer. As the downstream pressure approaches the pressure of the "reduced pressure zone", the secondary check valve will close. (Water pressure in the "RP zone" must exceed the downstream pressure in order to hold the secondary check valve open.)
2. **BACK-SIPHONAGE** - approaching zero or negative pressure on the supply side. When the supply pressure approaches zero or negative values, the primary check valve will close; the relief valve will spring open (draining the reduced pressure zone); the atmospheric vent passage to the reduced pressure zone will open; and the secondary check valve will close.



3. **BACKPRESSURE & BACK-SIPHONAGE SIMULTANEOUSLY**: The primary and secondary check valves would close, and the relief valve and atmospheric vent port would open.

#### 4. CHECK VALVES OR RELIEF VALVE MALFUNCTION

Malfunctioning of one or more of the three valves in the RPZ backflow prevent would not compromise the safety of the water supply (but there may be water discharging from the relief port until unit is repaired).



##### Secondary Check Valve

Backpressure: If some obstruction or wear prevents the secondary check valve from closing tightly, backpressure leakage would increase the central chamber pressure and thus open the relief valve and atmospheric vent port. (As chamber pressure approaches supply pressure, the relief valve springs open.)

##### Primary Check Valve

Back-siphonage: If the primary check valve were to foul, then simultaneously the relief valve would open, and the air passage from the atmospheric vent port would deliver air to an area just above the primary check valve. The air would satisfy any vacuum caused by back-siphonage. The air flowing to the primary check valve does not use the same passage in the relief valve used for draining water.

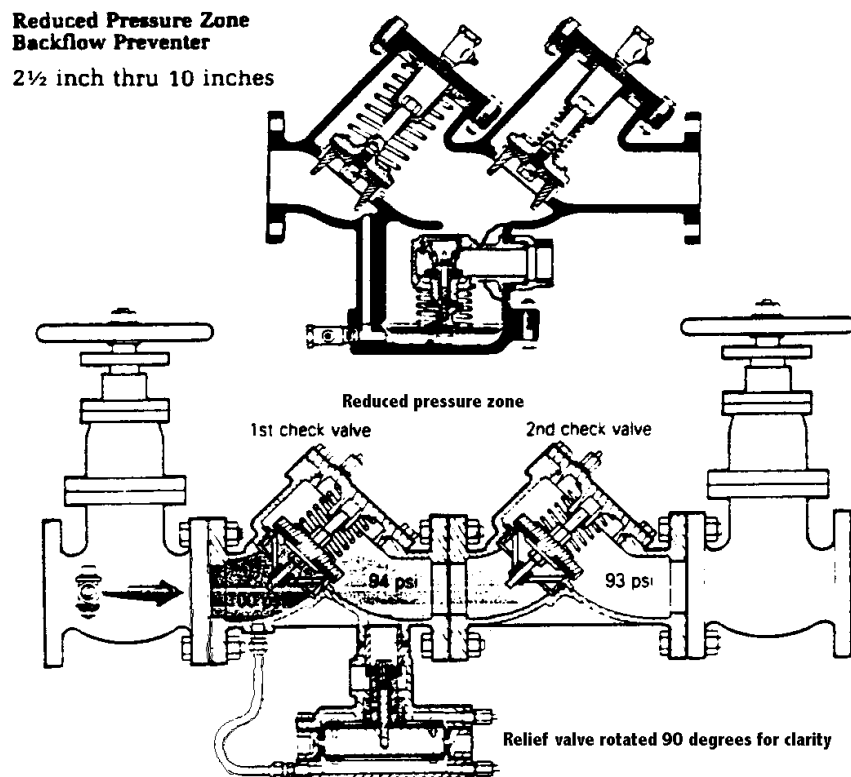
Backpressure: If the primary and secondary check valves were to fail simultaneously, then the water leaking back into the central chamber would exit through the relief valve.

##### Relief Valve/Port

A malfunctioning relief valve will not close; it will remain open, discharging water through the port until repaired. Even when fouled, the supply remains protected.

## RPZ INSTALLATION & USE:

1. Under no circumstances should plugging of the relief port be permitted.
2. The RPZ is equipped with test cocks and gate valves to enable required unit testing.
3. Several unit sizes are available for 3/4 to 10-inch supply lines. Approximate pressure losses across the unit are 10 to 20 psi, depending on the size and flow rate.
4. Install on each high hazard connection within a secondary system and/or at the service connection or water meter (for containment on the property) of car washes, autopsy and funeral parlors, commercial boilers, cooling towers, hospital and laboratory equipment, processing tanks, sewage treatment, etc.
5. The unit must be accessible for testing and service, and must be located above grade (not subject to flooding). The device must be installed at least 12 inches from any wall and between 12 to 30 inches above the floor.
6. Approved for **HIGH HAZARDS, CONTINUOUS PRESSURE, BACKPRESSURE OR BACK-SIPHONAGE**. ASSE standard #1013



## **DOUBLE CHECK VALVES**

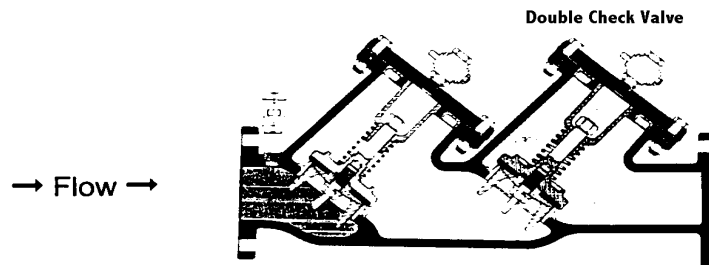
A double check valve backflow preventer consists of two check valves that are spring loaded in the closed position. These devices do not have the added protection of an atmospheric vent and therefore are limited to the amount of protection they offer and how they can be used. Some jurisdictions and codes do not permit double check valves to be used for backflow protection.

### **INSTALLATION & USE:**

1. Double check valves can only be used where they are approved for limited use with low hazard, continuous pressure conditions.
2. **THREE TYPES OF DOUBLE CHECK VALVES:**

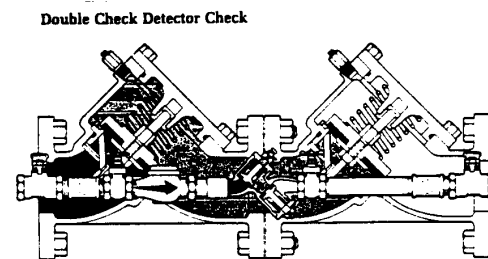
#### **I. DOUBLE CHECK VALVE**

This type of device is designed for commercial applications for 3/4 to 10-inch supply lines and contains test cocks and gate valves for testing purposes. ASSE standard #1015

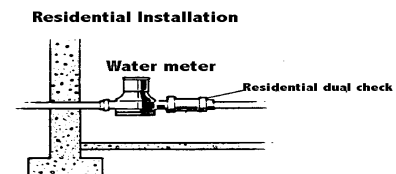
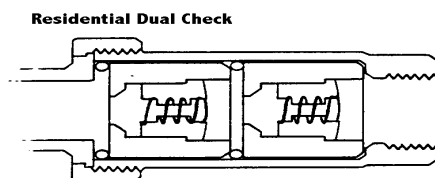


#### **I. DOUBLE CHECK DETECTOR CHECK VALVE**

This device is similar to the "double check" unit except that it has a water meter added to detect down stream leaks and unauthorized withdrawals. The unit is commonly installed on fire protection supply mains. ASSE standard #1048



**III. DUAL CHECK VALVE** The dual check valve is for residential applications only. When used, it is usually installed on the customer side of the water meter in an attempt to contain any pollutant (low hazard) within the resident's secondary system. The dual check valve is not equipped for in-line testing. ASSE standard #1024



## **VII. TYPICAL RETAIL FOOD SERVICE CROSS-CONNECTIONS**

NOTE: When evaluating the potential plumbing hazards for each fixture, there may be more than one type of backflow assembly or device that can be installed to protect a cross-connection (even if it exceeds minimum requirements to meet the hazard). In lieu of an air gap, is a cross-connection subject to backpressure and continuous or non-continuous pressure (all are subject to back-siphonage)? All inlets and cross-connections attached to the water supply are subject to back-siphonage, but not all are subject to backpressure. For specifications on proper installation and use for each device, review the previous pages.

The following are "typical" examples of equipment and backflow prevention devices required in lieu of an air gap. Remember, sometimes plumbing installations can be construed in a "nontypical" fashion; this does not mean that is necessarily wrong, but it will take more effort to evaluate the cross-connection control design.

1. **Prerinse or preflush hose:** (typically located at garbage grinders/disposals, pre-rinse or flushing stations prior to mechanical warewashing machines, or vegetable/prep sinks)

Units that are not equipped with a proper retainer spring (so an air gap above the flood level rim can be maintained when allowed to hang freely) must be provided with an appropriate backflow assembly or device. The type installed is dependent on the shut off valve location:

- a. Hand valve on spray nozzle: Since the entire supply line is subject to continuous pressure, the backflow device must be acceptable for use with continuous pressure and back-siphonage application. Backpressure is not an issue for a potential indirect cross connection. An in-line double check valve assembly with an intermediate atmospheric vent or pressure vacuum breaker (PVB) can meet the minimum requirements for continuous pressure.
- b. No valve on the spray nozzle or end of hose: The supply line from the shut off valve to the end of the nozzle is not subject to continuous pressure or backpressure. An atmospheric vacuum breaker (AVB) can meet the minimum requirements for non-continuous pressure and potential back-siphonage.

2. **Hose bibbs, threaded faucets** (inside & outside of establishment, fairgrounds, special vents, festival, etc.):

When a hose is attached directly to the faucet, a potential indirect cross-connection exists. Protected will depend on whether or not a shut-off device (pistol grip, etc.) is installed on the end of the hose.

- a. No shut off device on the end of the hose: The hose is not subject to continuous pressure or backpressure. A hose bibb vacuum breaker (HBVB) or atmospheric vacuum breaker (AVB) can meet the minimum requirements for non-continuous pressure and potential backsiphonage.

- b. A shut off device on the end of a hose: The backflow device is subject to continuous pressure and no backpressure. An in-line backflow prevention device with an intermediate atmospheric vent or a pressure vacuum breaker (PVB) can meet the minimum requirements for protection. (Note the PVB must be installed at least 12 inches above the maximum expected height that the hose end will be utilized.)

3. **Inlets which are or may become submerged:**

- A. Supply lines for a mechanical warewashing machine and dish conveyor belt.
- B. Supply inlet to a dish table trough or silverware and dish soak tanks.
- C. Supply line to a soap dispenser (detergent feeder) and/or drying agent for mechanical warewashing machines: The dispenser discharges the solution on the down stream side of AVB for the warewashing machine's supply line.
- D. Supply inlet to a garbage disposal with flushing rim: The submerged inlet is controlled by an electronic solenoid that supplies water to the waste being ground to form a slurry whenever the disposer is turned on.
- E. Garbage can washer. (If a jet rinse type, the inlet through the floor must be at least six inches above the flood level rim of the depressed area/sink).
- F. Perforated pipes to an oriental wok cooker.
- G. Supply inlet or fill line for equipment such as steam kettles, steam tables, dipper wells and coffee urns.

**Backflow prevention for items A-G:** Typically the atmospheric vacuum breaker is utilized on a submerged inlet for non-continuous pressure and potential back-siphonage. For continuous pressure and potential back-siphonage (no backpressure), a pressure vacuum breaker (PVB, can meet the minimum requirements for protection.

**Inlets which are or may become submerged,** Continued:

- H. Soap portioner on a faucet:  
The soap portioner must contain an internal air gap.
- I. Water wash system for an exhaust hood (self cleaning):  
Detergent feeder must discharge on the down stream side of the backflow prevention device and have an AVB for non-continuous pressure, PVB for continuous pressure or an in-line backflow prevention device with an intermediate atmospheric vent for continuous pressure and potential backpressure. A reduced pressure zone (RPZ) backflow prevention device may be required if toxic chemicals are added.

4. **Carbonators; for beverage dispensers:** Carbon dioxide (CO<sub>2</sub> from the carbonator that comes into contact with water will form carbonic acid (weak acid). If carbonic acid comes into contact with copper piping, copper will dissolve into the water and may result in copper poisoning (vomiting). Typically, the hazard exists for those consuming the first few softdrinks of the day. To prevent the backpressure of CO<sub>2</sub>, an in-line backflow prevention device with an intermediate atmospheric vent meeting ASSE Standard #1022 **must be installed between the carbonator and any copper supply line.**

5. **Boiler:**

a. with no chemicals added:

An in-line backflow prevention device with an intermediate atmospheric vent for continuous pressure and potential backpressure.

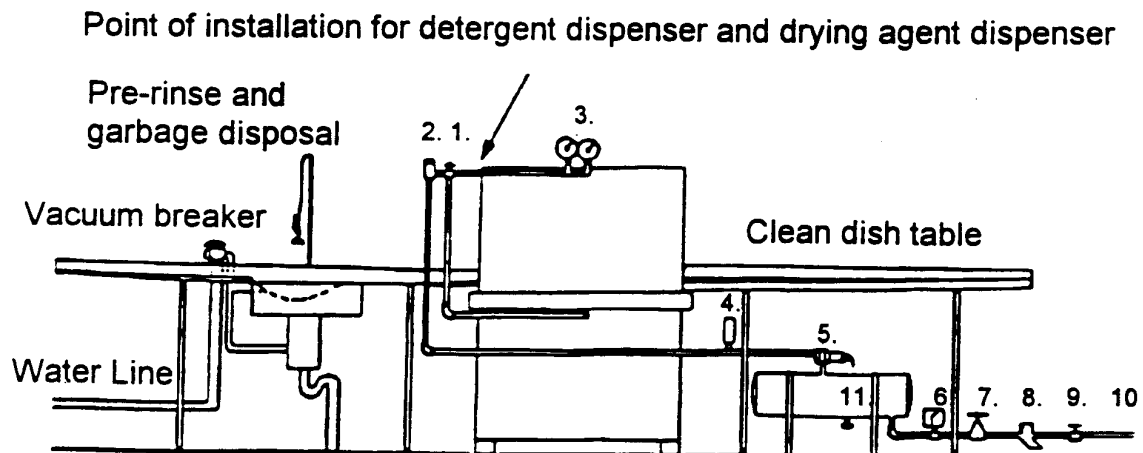
b. with chemicals added (high hazard):

A reduced pressure zone (RPZ) backflow prevention device would be required for toxic chemicals with potential backpressure and continuous pressure. The water supply line for the chemical additive reservoir must also be adequately protected.

6. **Water softening equipment:** with a continuous feed to a brine tank requires at least an in line backflow prevention device with an intermediate atmospheric vent to meet the minimum protection for continuous pressure.

7. **Lawn sprinkler system** with no potential backpressure: An AVB for non-continuous pressure and a PVB for continuous pressure would meet minimum requirements for backflow protection. If chemicals are added a RPZ may be required.

## TYPICAL MECHANICAL WAREWASHING INSTALLATION



- |                                      |  |
|--------------------------------------|--|
| 1. Gauge cock for tests              | 7. Pressure reducing valve<br>(set at 15-25 psi) |
| 2. Vacuum breaker                    | 8. Strainer                                      |
| 3. Wash and final rinse gauges       | 9. Cut- off valve                                |
| 4. Shock arrestor (recommended)      | 10. 140 degree water supply                      |
| 5. Pressure-temperature relief valve | 11. Booster heater                               |
| 6. Pressure-temperature gauge        |  |

## VIII. AIR GAES & AIR BREAKS FOR DRAINS & WASTE

An indirect connection between the water supply or food service equipment and the facility's drainage or wastewater disposal system is necessary to prevent wastewater from backflowing (back-siphonage or backpressure) into the supply or into equipment where food, kitchenware or utensils are retained.

**DIRECT CONNECTION:** A waste line or pipe from a fixture, receptacle or device that discharges used water, waste materials or sewage directly into the facility's drainage system.

**INDIRECT CONNECTION:** A waste line or pipe from a fixture, receptacle or device that discharges used water, waste materials or sewage into the facility's drainage system through an "air gap" or "air break." Thus, there is no direct connection between the two systems.

**AIR GAP:** is the unobstructed, vertical air space that separates the end of a supply-line and the flood level rim of a receptacle. This receptacle may be a sink, coffee urn, steam kettle, floor drain, floor sink, etc. The air gap must be the greater of the two - a minimum of one inch or twice the inside diameter of the supply pipe.

**AIR BREAK:** is a waste line or pipe from a fixture that discharges used water or liquid waste into another fixture or receptacle at a point below the flood level rim, i.e., the waste line from a vegetable preparation sink that drains into a floor drain. (Restated: an air break is an indirect connection that does not have an "air gap.") *(Note: some jurisdictions do require the waste line to terminate above the flood level rim of the floor, sink or drain.)*

### 1. **Booster heater for warewashing machine:**

Provide an air gap between the relief valve vent pipe and the floor drain or floor sink.

### 2. **Waste-cooled condenser for an ice machine or other refrigeration system:**

Provide an air gap between the end of the supply line and the floor drain or floor sink. (The supply line water still remains as part of the supply system as it cools. The cooling water is not exposed to potential outside contamination until it exits the unit.)

### 3. **Drain lines for food service equipment** such as salad cooler table or salad bar, ice machine or ice bin, soda fountain/dispenser, steam kettle and steam table: Provide an air break.

### 4. **Condensate drain lines** for refrigeration equipment: Provide an air break.

**5. Water softening equipment:**

- a. Brine tank drains through a hose bibb (potential indirect cross-connection with a drain hose): a hose bibb vacuum breaker (HBVB) can meet the minimum requirements for non-continuous pressure and potential back-siphonage.
- b. Brine tank with a gate or ball valve: drain line must be air gapped.

**6. Exceptions to indirect wastes:**

- a. Warewashing machines located within five feet of a trapped floor drain may have a direct waste connection to inlet side of a properly vented floor drain trap.
- b. Garbage disposals require a direct connection to prevent the solids from separating out from the waste slurry.
- c. Other exceptions as provided by law or regulation.

## **IX REFERENCES & RESOURCES**

- 1 American Society of Sanitary Engineering (ASSE)  
28901 Clemens Road, Suite 100 (216) 835-3040 fax (216) 835-3488  
Westlake, OH 44145 E-mail: ASSE@IX.netcom.com

### **ASSE Standards for Cross-Connection Control**

- 1001 - Pipe Applied Atmospheric Type Vacuum Breakers, ASSE/ANSI - 1990
- 1002 - Water Closet Flush Tank Ball Cocks, ASSE - 1986
- 1011 - Hose Connection Vacuum Breakers, ASSE/ANSI - 1995
- 1012 - Backflow Preventer with Intermediate Atmospheric Vent, ASSE/ANSI - 1995
- 1013 - Reduced Pressure Principle Backflow Preventers, ASSE - 1993
- 1015 - Double Check Backflow Prevention Assembly, ASSE - 1993
- 1019 - Vacuum Breaker Wall Hydrants, Freeze Resistant Automatic Draining Type,  
ASSE/ANSI - 1995
- 1020 - Pressure Vacuum Breaker Assembly, ASSE/ANSI - 1990
- 1021 - Drain Air Gaps for Domestic Dishwasher Applications, ASSE - 1977
- 1022 - Backflow Preventer for Carbonated Beverage Machines, ASSE - '1996
- 1024 - Dual Check Valve Type Backflow Preventers, ASSE - 1994
- 1032 - Dual Check Valve Type Backflow Preventers, ASSE -1980 (carbonating units)
- 1035 - Laboratory Faucet Backflow Preventers, ASSE/ANSI - 1995
- 1047 - Reduced Pressure Detector Backflow Preventer, ASSE/ ANSI - 1995
- 1048 - Double Check Detector Assembly Backflow Preventer, ASSE/ANSI - 1995
- 1052 - Hose Connection Backflow Preventers, ASSE/ANSI - '1994
- 1055 - Chemical Dispensing Systems, ASSE - 1997
- 1056 - Back-Siphonage Backflow Vacuum Breakers, ASSE/ANSI - 1995
- 1060 - Outdoor Enclosures for Backflow Prevention Assemblies, ASSE - 1996

Prepared By: N.C. Food, Lodging, and Institutional Sanitation Branch  
Plan Review Subcommittee

3. American Water Works Association (AWWA)  
6666 West Quincy Avenue (303) 794-7711  
Denver, CO 80235  
Homepage: <http://www.awwa.org>
3. FEBCO  
P.O. Box 8070(209) 252-0791 fax (209) 453-9030  
Fresno, CA 93747-8070 Homepage: <http://www.cmb-ind.com>
4. Foundation for Cross-Connection Control and Hydraulic Research  
University of Southern California (213) 740-2032 fax (213) 740-8399  
KAP-200 University Park MC-2531 E-Mail: [fccchr@usc.edu](mailto:fccchr@usc.edu)  
Los Angeles, CA 90089-2531 Homepage: <http://www.usc.edu/dept/fccchr>
5. Plumbing and Drain Institute (PDI)  
1106 West 77 1h Street South Drive  
Indianapolis, IN 46260 (317) 251-6970
6. Plumbing Related Associations & Publications  
Homepage: <http://www.PlumbingSupply.com/public.html>
7. Wafts Regulator Company  
815 Chestnut Street (508) 688-1811 fax (508) 794-1848  
North Andover, MA 01845  
Homepage: <http://www.waftsreg.com>
8. Zurn Industries, Inc.  
Hydromechanics Division  
1801 Pittsburgh Avenue  
Erie, PA 16514 (814) 455-0921 fax (814) 454-7929
9. Food and Drug Administration  
Division of Human Resource Development  
5600 Fishers Lane, HFC-61  
Rockville, Maryland 20857 (495) 443-5871

## **Section 12. Grease Interceptors And Automatic Grease/Oil Removal Units**

Oil and grease entering a facility's drainage waste system will eventually solidify somewhere' -- down stream and eventually clog the sewer line and/or cause potential problems for the onsite or public sewage system. The oil and grease from foods and cooking liquefy at high water temperatures primarily originating from the three compartment sink, warewashing machine or some pieces of equipment such as an oriental wok cooker.

Oil and grease can occur in a combination of four forms:

1. **Dissolved oil** is oil that has dissolved in the water via a degreasing compound and will not separate from the water.
2. **Chemically emulsified oil** is oil that has been broken down into very small particles via a detergent and will not float to the surface.
3. **Free oil**, which is the majority of the oil produced in a food service facility, is not dissolved or chemically emulsified but is in a liquid form that is available to float to the water surface-when it is -allowed to-coalesce (consolidate or-congeal on the water surface).
4. **Mechanically emulsified oil** is free oil that has been agitated in water to form small droplets. These droplets will congeal, as free oil does, provided enough time is allowed for the process.

### **HOW GREASE INTERCEPTORS WORK**

A grease interceptor (or grease trap) is a chamber designed for wastewater to pass through and allow any free or mechanically emulsified oil to float to the top for retention as the remainder of the effluent passes through. (This concept is similar to a septic tank, but remember a septic tank is designed to collect solids on the bottom and scum on the top of the tank.) For the oil to float to the top, it is necessary to calm the water as turbulence only perplexes the separation. To assist in the ponding or calming process, the waste water enters through an inlet baffle and may pass through additional baffles before exiting through the outlet baffle. Flow rate (volume of water per unit of time, i.e. 7 gallons per minute [GPM]) affects time and turbulence in the interceptor. Too fast a flow rate does not allow the "time" necessary for separation and creates turbulence. Thus, many of these installations are equipped with a flow control valve prior to the inlet baffle.

Only the facility's grease laden waste should be plumbed to the grease trap, otherwise suspended solids would fill the unit and a larger tank would be needed for the higher volume of waste water. Also, some installations are designed with a solids strainer prior to the interceptor, to prevent solids from interfering with grease separation.

## **SIZING THE INTERCEPTOR**

Trap installations are designed and sized based on anticipated flow rates and organic load for maximum efficiency. Specific gravity (density) of the grease filtrates affects the time necessary for separation. For example, the specific gravity of water is 1.0, thus the lower the specific gravity of the oil, the less time it takes to separate and float to the top of the tank. Also, the higher the flow rate, ratio of grease to water, suspended solids, and total grease volume to be retained between cleaning/emptying, the larger the grease interceptor must be.

## **INTERCEPTOR LOCATION**

Grease traps range in size from 35 gallon units located inside the kitchen area to 1,000 gallon in-ground installations outside the facility. Installation should be properly vented and as close to the source as possible but in a manner that facilitates the ease of cleaning and service without creating a nuisance.

### **Automatic Grease/Oil Removal Units Used In Conjunction Or In Place Of Standard Vault Type Grease Interceptor.**

## **Trend Analysis: Good News - Bad News**

The good news is that there are record numbers of restaurants in the U.S.A. The bad news is that these restaurants are discharging record amounts of grease and foodstuffs into sewage collection systems.

The salient factors affecting a restaurant, hospital kitchen, school cafeteria, casino or other food processing facility are:

- a. Ware-washing equipment.
- b. Production equipment
- c. Menu
- d. Management/operating practices

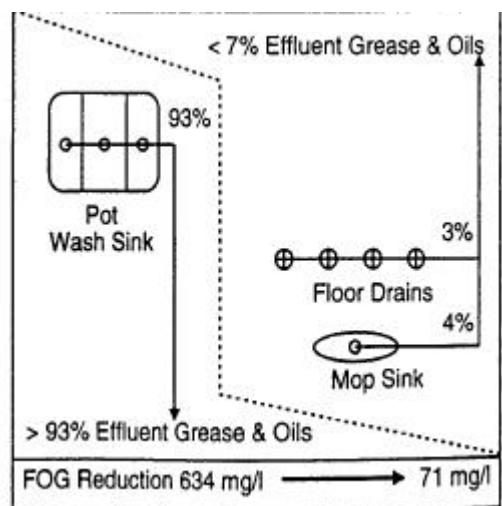
Although there are a wide span of restaurants and food handling facilities, they tend to fall into four distinct categories: 1) Past-Food, 2) Full-Service Restaurants, 3) Institutional Kitchens and 4) Special Sites. The choice of automatic grease removal system relates to these four categories. In all cases, ware-washing and production equipment is taken into consideration as you design to reduce FOG (fats, oils and grease) and BOD (Bio-chemical oxygen demand - the amount of digestible foodstuffs) present in the effluent.

## **Fast-Food Restaurants**

Fast-food restaurants have the simplest production equipment. In a fast-food kitchen nearly 93% of all fats, oils, greases and other foodstuffs pass into the three compartment pot washing sink.

**Tips.** The more fryer-type cooking appliances, the high levels of effluent grease and oils. An one automatic grease/oil removal unit point source system in a fast food restaurant servicing a three compartment sink typically removes 6 to 9 lbs. (2.7 - 4.1 kg) of grease per day.

## **Typical Fast food Grease Source of Fixture**

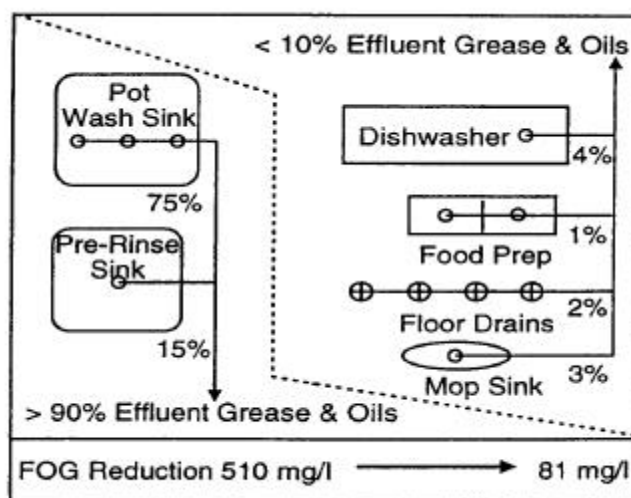


## **Full Service Restaurants**

Full service restaurants offering table service with washed, nearly 90% of all fats, oils, greases and other foodstuffs pass into the three compartment sink (75%) and the pre-rinse sink at dishwashing (15%).

**Tip:** To minimize effluent FOG values, do not route the dishwasher discharge into the grease interceptor or automatic grease removal system. Dishwasher flows are rich in detergent and emulsify a high percentage of the separated fats held in a grease trap or other kind of separator. This is frequently seen at sites where the sewer district's sampling shows high levels of FOG, but visual inspection shows only minor amounts of free-floating fats and oils in the grease trap.

## **Typical Full-Service Restaurant: Grease Sources By Fixture**

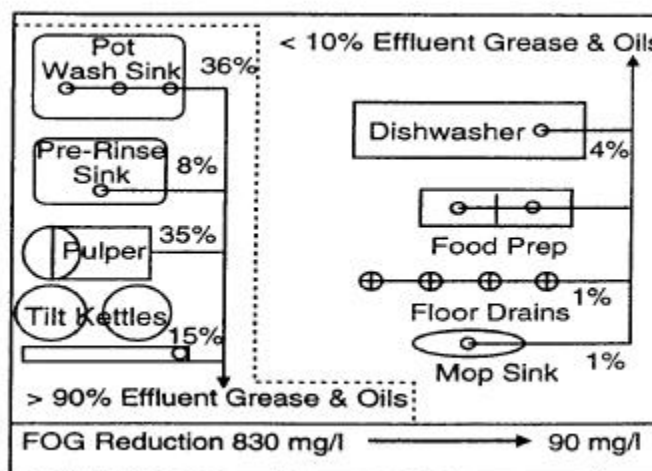


## **Institutional and Large Commercial Kitchens**

These large, multi-purpose kitchens utilize a wide range of warewashing and food preparation equipment. The increased number of grease bearing point sources generally mandates use of central-type automatic grease removal systems. One large automatic grease/oil removal unit servicing a 300 bed hospital kitchen typically removes a barrel of grease every 10 to 14 days.

**Tips.** Rarely seen in full service kitchens, tilt kettles which are used to cook large volumes of cooked meats, soups, sauces and other foods are installed in more than 70% of institutional kitchens. Tilt kettles can put large volumes of greases and foodstuffs into the drainage system. Large institutional kitchens such as prisons, hospitals, and college cafeterias also frequently incorporate potato peelers, pulpers, bakery sinks, wet hoods and other equipment that can discharge high volumes of greases and other foodstuffs into the drainage system. When specifying central removal systems for institutional kitchens, determine the maximum drainage flow value and provide at least 100 pounds (45 kg) of grease removal capacity per day.

**Typical Institutional Kitchen:  
Grease Sources By Fixture**



## **Special Food Preparation Sites**

Casinos, military mess halls, large correctional institutions and food processing plants often have a negative effect on a sewer system. For example, casinos serve high volumes of food 24 hours per day. The casino is often in a location such as a waterfront, which requires the sewage to be pumped through one or more lift stations. This leads to high sewer maintenance costs and high effluent FOG numbers. Automatic grease removal systems are steadily gaining favor with casino operators because of their round the clock operation. More than 40% of all U.S. casinos are equipped with automatic grease removal systems ranging from the smallest one automatic grease/oil removal units to the largest systems.

**Tip:** When selecting an automatic removal system, determine the peak flow volume. The gallons per day figure are not as important as determine the peak flow value. Peak flow volume can be determined by using the following sizing information.

References: Big Dipper-Thermaco® 646 Greensboro Street, Asheboro, North Carolina 27203  
Telephone: 336.629.4651 Toll Free: 800.633.4204 FAX: 336.626.5739 E-mail: info@thermaco.com

## **SECTION 13 - INSECT AND RODENT CONTROL**

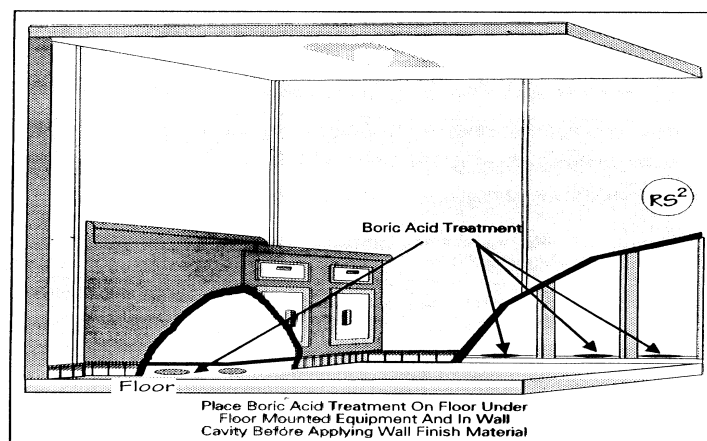
Openings to the outside shall be effectively protected against the entrance of rodents and insects by the installation of tight fitting self-closing doors, closed windows, self-closing windows at drive-through, screening, controlled air currents at delivery doors, vestibules or other approved means. Screening for windows, doors, skylights, transoms, intake air ducts and other openings to the outside shall be tight fitting and free of breaks in the screening material. Screening material should not be less than sixteen mesh to the inch. Doors, door jams and openings between the floor and bottom of outer doors shall be adequately flashed with a rodent proof material to eliminate any openings.

Openings within the establishment around pipes, or conduit shall be tightly sealed. Openings on the outside of buildings shall be sealed with sheet metal, concrete or brick and mortar.

Eliminate potential vermin harborage by sealing all cracks and crevices. Cracks and crevices in excess of 1/32" shall be sealed with an approved caulking compound to provide a smooth and sanitary installation.

Caulk used in a food zone area shall be FDA or NSF approved for use.

Horizontal spaces, which will be rendered inaccessible after construction or equipment installation (such as wall cavities and areas underneath walk-in coolers or cabinets), should be treated with an approved material to prevent the possibility of roach infestation. **(Figure 14 shows areas where treatment for insect control should be applied)**



**Figure 14**

Loading docks and delivery doors should be provided with effective air curtains, vestibules, or with self-closing doors to preclude the entrance of insects. It is recommended that outside lighting around loading areas and entrances to be sodium vapor rather than mercury vapor to decrease insect attraction.

## **SECTION 14 - LIGHTING**

Permanently fixed artificial light sources shall be installed to provided in all areas in which food is prepared, or in which utensils are washed, shall be provided with at least 50 foot-candles of light on food preparation work levels and at utensil washing work levels.

At least 10 foot-candles of light at 30 inches above the floor shall be provided in all other areas, including storage rooms and walk-in units. This shall not include dining and lounge areas except during cleaning operations. Fixtures shall be kept clean and in good repair.

Light bulbs in food preparation, storage, and display areas shall be shatter-proof or shielded so as to preclude the possibility of broken bulbs or lamps falling into food. Shatter-proof or shielded bulbs need not be used in food storage areas where the integrity of the unopened packages will not be affected by broken glass falling onto them and the packages, prior to being opened, are capable of being cleaned.

Heat lamps shall be protected against breakage by a shield surrounding and extending beyond the bulb, leaving only the face of the bulb exposed.

## **SECTION 15 - VENTILATION**

All rooms of a permitted retail food establishment should be adequately ventilated and kept reasonably free of grease, excessive heat, steam, condensation, vapors, smoke, and fumes. Mechanically introduced make-up air shall be provided as necessary. Ventilation systems shall be designed and installed according to state building codes.

The following information is provided to offer guidance in meeting the requirement for ventilating cooking equipment. There are several methods used in calculating the volume of air movement, measured in Cubic Feet per Minute (CFM), necessary to effectively and efficiently ventilate cooking equipment. While these methods are used in general applications, it must be noted that engineered exhaust systems which are customized for specific equipment under specific use conditions may also be approved by the building code official or fire marshall.

### **General Principles of Exhaust**

The purpose of an exhaust hood is to provide a method of collecting, as nearly as possible, all of the grease produced from the cooking process, while furnishing a means of removing heat, smoke, and odors from the cooking area.

For the hood to fulfill its purpose there must be a sufficient volume of air movement (capture velocity) to draw grease particles and cooking vapors directly from the cooking surface to the grease extractors. This air flow removes cooking odors and keeps grease particles from settling onto nearby surfaces.

An effective capture velocity shall be sufficient to overcome opposing air currents, capture the grease and cooking vapors, and transport them directly to the grease extractors.

Grease extractors are ineffective in removing grease vapors. Only when grease vapors cool and condense can an extractor remove grease particles by directed air flow, contraction, and expansion (drop out). It is essential to have a sufficient volume of air flowing to cool and condense the grease vapors into grease particles prior to reaching the grease extractors.

Non-toxic smoke bombs may be used to evaluate and regulate kitchen exhaust hoods and supply systems. No fabricator of exhaust hoods can create all the conditions in the plant that the hood must cope with on the job site to function correctly.

In the case of heat and steam producing equipment, the purpose of the hood or ventilation system (such as a pants-leg duct system) is to control humidity, heat, and unwanted condensation.

A major cause of unacceptable hood performance is a lack of coordination between the Heating, Ventilation, and Air Conditioning (HVAC) system and the exhaust hood system. These systems should be coordinated prior to installation, and balanced when installation is completed, to ensure the proper performance of both.

## **Fire Protection**

Exhaust ventilation systems for all grease producing cooking equipment is under the jurisdiction of the State Fire Marshal's Office and local fire and building officials. System designers and/or owners should contact these officials regarding fire safety plan review and inspection.

### **Hood Size**

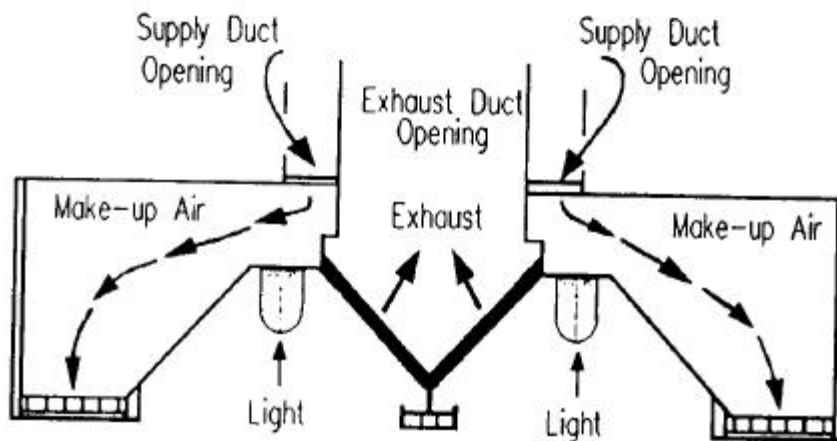
1. Canopy hoods and island hoods shall have a minimum depth of two feet and shall extend at least six inches beyond any equipment being ventilated, except that no overhang will be required on sides where aprons are installed. The dimensions of the hood are, in all cases, larger than the cooking surface to be covered by the hood. The amount of overhang of the hood depends upon the clearance or distance between the base of the hood and the top of the cooking equipment. A rule of thumb for the overhang on canopy hoods is 0.4 of the distance from the cooking surface to the bottom of the hood, but in any case, no less than six inches.

#### **Example:**

Hood overhang = distance from bottom of hood to top of range =  $0.4 \times 3.25 \text{ ft.} = 1.30 \text{ ft.}$ , or approximately 1 foot, 4 inches

Canopy hoods shall be installed so that the bottom of the hood is between 6.5 feet and 7 feet above the finished floor.

**(Figure 15 illustrates a canopy hood.)**

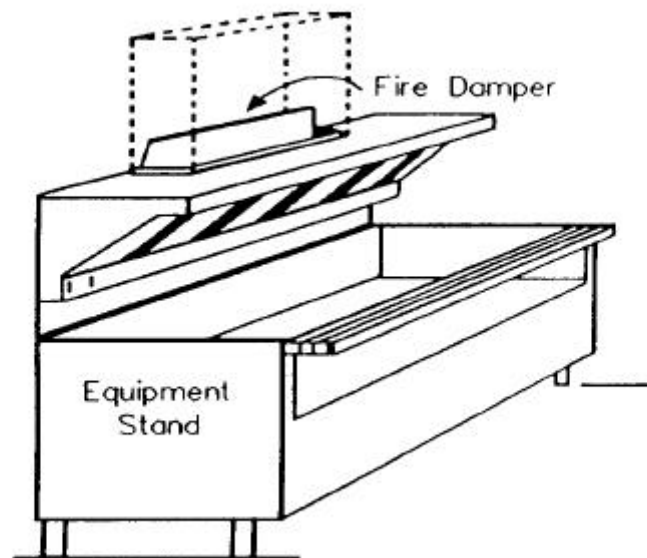


**FIGURE 15.**

2. Ventilator, or "backshelf", hoods are designed to mount to the wall directly behind the cooking equipment. This type of hood is often used where ceiling height is a factor. It is normally placed closer to the cooking surfaces than a canopy hood, and works well in light to medium duty cooking applications. The ventilator hood is not recommended for charbroilers or similar high heat and grease producing cooking equipment. It does not have the capture area of a canopy hood and is not able to effectively handle large surges of cooking emissions (steam, heat, vapors, etc.)

Several dimensions are essential in the proper installation of a ventilator hood. Ventilator hoods shall extend from the wall a minimum of 16 inches, and shall be installed so that the distance from the top of the cooking equipment to the bottom of the ventilator hood is no more than 24 inches. Equipment placed under a ventilator hood shall not extend beyond the sides of the hood or more than 36 inches from the back of the hood. These restrictions are necessary to ensure maximum capture and removal of cooking emissions.

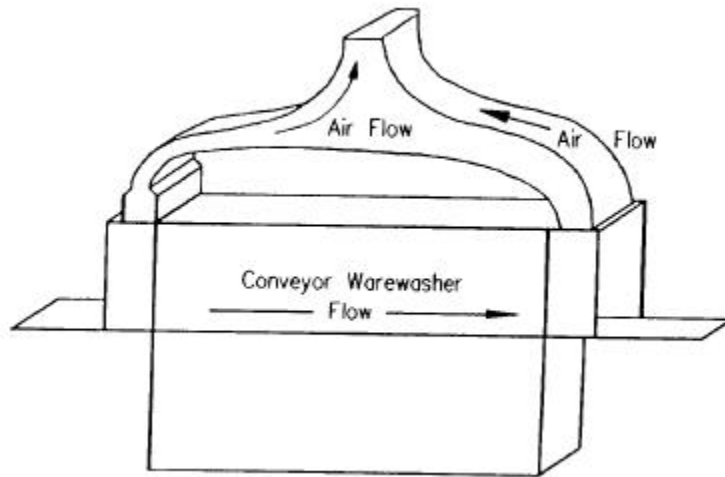
(Figure 16 illustrates a ventilator hood.)



**FIGURE 16.**

3. Pants-leg exhaust systems are designed to remove the heat or steam close to the point of discharge from warewashers or conveyor cooking equipment. These systems must be sized to effectively ventilate the equipment served.

**(Figure 17 illustrates a pants-leg duct system.)**



**FIGURE 17.**

4. Eyebrow hoods are designed to immediately remove heat from an oven at the point of emission or as the door is opened. These hoods must effectively ventilate the door openings of the equipment served.

**(Figure 18 illustrates an eyebrow hood.)**



**FIGURE 18.**

## **Exhausted Air**

The amount of air exhausted through a hood exhaust system is dependent upon the size of the hood, its particular installation, and its use. There are several methods available for determining the amount of air to be exhausted. With the exception of systems engineered for specific equipment and specific applications that are approved by the health authority, the following criteria shall be used to calculate the amount of air exhausted:

1. Canopy hoods.
  - A. Standard square foot method.

This method of calculating exhaust air volume is based on the size of the opening in the hood (length x width) and the capture velocity relative to the installation of the hood (see Table I).

Hood length x hood width = square feet (ft.<sup>2</sup>) of hood opening.

Ft.<sup>2</sup> of hood opening x factor from Table I = CFM of air exhausted.

**TABLE I.**

<u>Exposed sides</u>	<u>Factor(CFM/ft.<sup>2</sup>)</u>
4 (central island hood)	125
3 (wall hung hood)	100
2 (corner hung hood, or with aprons)	85
Steam or heat exhaust only	70

Example:

8 ft. (length) x 4 ft. (width) = 32 ft.<sup>2</sup>  
32 ft.<sup>2</sup> x 100 CFM/ft.<sup>2</sup> (wall hung hood) = 3200 CFM

- B. Exposed linear foot method.

This method of calculating the exhaust air volume is based on the total exposed linear footage of the hood and the capture velocity relative to its application (see Table II).

Exposed linear footage of hood x factor from Table II = CFM of air exhausted.

**TABLE II**

Application Factor (CFM/in. ft.)

Light duty (no grease, light grease)	150 - 250
Medium duty (fryers and griddles)	250 - 350
Heavy duty (heavy grease, charbroiler)	350+

Example:

4 ft. x 8 ft. hood (light grease), 3 exposed sides

4 ft. + 8 ft. + 4 ft. = 16 exposed linear ft.

16 exposed linear ft. x 250 CFM/linear ft. = 4000 CFM

C. Square feet of cooking surface method.

This calculation of the volume of exhausted air depends on the size, temperature, and design of the cooking equipment and the minimal capture velocity required to keep smoke, vapors, and fumes under the hood. The amount of air to be removed is calculated by multiplying the surface area of the equipment (ft.<sup>2</sup>) by the appropriate updraft velocity factor (see Table III); total air exhausted is the sum of exhaust air volumes of all the equipment added to the minimal capture velocity.

Ft.<sup>2</sup> of cooking surface of each piece of equipment (length x width) x the updraft velocity factor from Table III = CFM of exhaust required for each piece of equipment.

**TABLE III.**

Application	Updraft velocity factor
Steam kettles, ranges, ovens, non-grease producing equipment	50 fpm
Fryers/griddles, grease Producing equipment	85 fpm
Charbroilers, high heat and grease producing equipment	150 fpm

**Example:**

<u>Equipment</u>	<u>Square feet</u>
oven	30" x 36" = 7.5 ft. <sup>2</sup>
fryer	18" x 24" = 3.0 ft. <sup>2</sup>
charbroiler	32" x 54" = 7.6 ft. <sup>2</sup>
range	42" x 34" = 9.6 ft. <sup>2</sup>

<u>Ft.</u>		<u>Factor</u>	<u>Exhaust</u>
7.5	X	50 fpm	375 CFM
3.0	X	85 fpm	255 CFM
7.6	X	150 fpm	1140 CFM
9.6	X	85 fpm	<u>816 CFM</u>

Total equipment exhaust volume = 2586 CFM

The minimal capture velocity = [hood opening area (ft.<sup>2</sup>) - cooking equipment surface area (ft.<sup>2</sup>)] x 50 fpm

**Example:**

4 ft. x 15 ft. hood = 4 ft. x 15 ft. = 60 ft.<sup>2</sup> hood opening

Cooking equipment surface area (from above) = 7.5 ft.<sup>2</sup> + 3 ft.<sup>2</sup> + 7.6 ft.<sup>2</sup> + 9.9 ft.<sup>2</sup> = 28 ft.<sup>2</sup>

Minimal capture velocity = (60 ft.<sup>2</sup> - 28 ft.<sup>2</sup>) x 50 fpm = 32 ft.<sup>2</sup> x 50 fpm = 1600 CFM

Total system exhaust volume = equipment exhaust volume + minimal capture velocity

**Example:**

Total system exhaust volume = 2586 CFM (from above) + 1600 CFM (from above) = 4186 CFM

## 2. Ventilator and backshelf hoods.

Linear footage of hood x ventilator exhaust factor from Table IV = CFM of air exhausted.

**TABLE IV.**

<u>Application</u>	<u>Exhaust Factor</u>
Light duty (non-grease producing)	200 CFM/ft.
Medium duty (light grease producing)	275 CFM/ft.
Heavy duty (heavy grease producing)	350 CFM/ft.

**Example:**

12 ft. ventilator hood, medium duty (light grease producing)  
12 ft. x 275 CFM/ft. = 3300 CFM air exhausted

**Duct Location and Size**

Exhaust ducts should never be located at the sides of the hood. For hoods that are six feet or less in length, only one outlet should be provided. Long hoods should be provided with multiple outlets no closer than six feet apart and no further than 12 feet apart. For hoods equipped with multiple ducts, it is advisable to install a manual air volume damper on each outlet so that the system can be easily balanced.

A duct velocity of no less than 1500 fpm shall be provided to maintain suitable conditions in the duct work. In some cases, a greater duct velocity (i.e. 1800 - 2200 fpm) may be necessary for the system to function at its best. The cross-sectional area of the exhaust duct (in ft.<sup>2</sup>) can be calculated by using the following formula:

Duct area required (ft. <sup>2</sup>) = Volume of air exhausted (CFM) / Duct velocity (fpm)

**Example:**

Duct area required (ft. <sup>2</sup>) = 3000 CFM / 1500 fpm = 2 ft. <sup>2</sup>

The area of round duct can be determined from Table V.

**TABLE V.**

Sizing Chart for Round Duct

<b>Duct Diameter</b>	<b>Duct Area (In.<sup>2</sup>)</b>	<b>(Ft.<sup>2</sup>)</b>
10 inches	78.54	.545
12 inches	113.1	.785
13 inches	132.7	.9218
14 inches	153.91	.069
15 inches	176.71	.227
16 inches	201.01	.396
18 inches	254.41	.767
19 inches	283.51	.969
20 inches	314.12	.182
21 inches	346.32	.405
22 inches	380.12	.640
24 inches	452.33	.142

Once removed, the grease is drained into a collection container in the hood or elsewhere. Extractors have generally replaced wire mesh filters where grease removal is of prime concern and compliance with National Fire Protection Association (NFPA) codes is required. Wire mesh filters may be used to exhaust pizza ovens, bread and pastry ovens, and other similar equipment where grease is not of prime concern. Both wire mesh and extractor type filters have an efficient operating velocity range of 200 to 500 fpm; the operating velocity of the filters shall not be less than 200 fpm.

### **Grease Filter Area and Number of Grease Filters Required**

There are two general types of grease filters: wire mesh and extractor filters. The extractor filter removes grease in the exhaust process by centrifugal motion or by impingement on a series of baffles. The manufacturer's optimum rating of the filter should be used in calculating the filter area required in the exhaust system. Standard size filters should be used to avoid additional cost and to allow ease of replacement. Any space in the filter bank not covered by filters/extractors shall be fitted with sheet metal blanks. If calculations indicate that a fraction of a filter is needed, add an additional filter. The filter area required for an exhaust system can be calculated by using the following formula:

Filter area needed (ft.<sup>2</sup>) = Volume of air exhausted (CFM) / operating velocity of the filters (fpm)

Example:

Filter area needed (ft.<sup>2</sup>) = 3200 CFM / 500 fpm = 6.4 ft.<sup>2</sup>

Filters are sized and made removable so that they may be passed through a warewashing machine or cleaned under a steam jet. Standard size grease filters are:

12 inches x 16 inches  
16 inches x 20 inches  
16 inches x 25 inches  
20 inches x 20 inches  
20 inches x 25 inches

The following example illustrates how to determine the number and size of filters needed.

**Example:**

1 ft.<sup>2</sup> = 144 in.<sup>2</sup>; a 16 in. x 20 in. filter = 320 in.<sup>2</sup>

320 in.<sup>2</sup> / 144 in.<sup>2</sup> = 2.22 ft.<sup>2</sup>

3 filters of 16 in. x 20 in. = 6.66 ft.<sup>2</sup>; therefore, 3 filters of 16 in. x 20 in. will meet the filter area requirement of 6.4 ft.<sup>2</sup> calculated in the previous example.

## **Calculating Static Pressure**

To select the proper size fan, the volume of air to be moved and the total resistance to its movement must be known. There are a number of restrictions in an exhaust system which affect air flow. The resistance to air movement is measured in inches of water, and this friction loss is called static pressure (S.P.).

The static pressure against which the exhaust fan must work is considered to be the sum of the following five items:

1. The resistance of the grease filters measured under heavy use. A value of .2 inches of water is ample for most filters.
2. The "entrance loss" of static pressure occurring where the exhaust duct attaches to the hood will be about .1 inch of water.
3. The resistance created by natural winds blowing on the exhaust duct opening is a matter of judgement; the average wind pressure is approximately .15 inches of water.
4. The energy, or accelerating pressure, required to accelerate the air to the duct velocity, usually about .20 inches of water.
5. The resistance of the exhaust ducting, which is determined by the total length of the straight duct plus the number and type of elbows.

The values used to determine the static pressure that a fan must overcome are specified in Table VI.

**TABLE VI.**

Type of resistance	Amount of resistance	
filter	.20	inches
hood entrance loss	.10	inches
wind pressure	.15	inches
accelerating pressure	.20	inches

### **DUCT RESISTANCE**

straight duct = .0025 inches per linear ft.

angles	= 90°	.20 inches each
	= 45°	.10 inches each
	= 30°	.05 inches each

**Example:** An exhaust hood with a straight duct of 8 feet with two 45° elbows

	Static Pressure
Duct (8 ft. x .0025)	= .02 inches
Elbows (2 x .10)	= .20 inches
Filter resistance	= .20 inches
Hood entrance loss	= .10 inches
Wind pressure	= .15 inches
<u>Accelerating pressure</u>	= <u>.20 inches</u>
Total	= .87 inches

### **Fan Size**

The exhaust fan shall be sized to remove the amount of air to be exhausted at the required static pressure.

### **Make-up Air**

The term "make-up air" is used to identify the supply of outdoor air to a room or building to replace the air removed by an exhaust system. For a consistent and regulated flow, make-up air should be mechanically introduced by a fan, swamp cooler, etc. Mechanically introduced make-up air shall be supplied as part of the exhaust system when the amount of air to be exhausted exceeds 1500 CFM.

Make-up air is critical to the design of a ventilation system. It is generally recognized that all systems exhausting more than 1500 CFM need mechanically introduced make-up air to ensure a balanced system. Mechanical engineers recommend that make-up air be supplied at 85 to 90 percent of the exhausted air. Make-up air controls should be interlocked with exhaust controls to ensure that the units operate simultaneously. Replacement air shall be filtered and may also be tempered by a separate control. The air velocity through the make-up air system should be low enough to avoid the possibility of drafts. It is desirable to have the kitchen under a very slight negative pressure to prevent any filtration of cooking odors from the kitchen into the dining room. The supply of make-up air is frequently introduced at some point within the hood, or in close proximity to the hood, to avoid the removal of conditioned air that has been heated or cooled.

The make-up air inlet should be located at least 10 feet from the exhaust fan to comply with NFPA requirements.

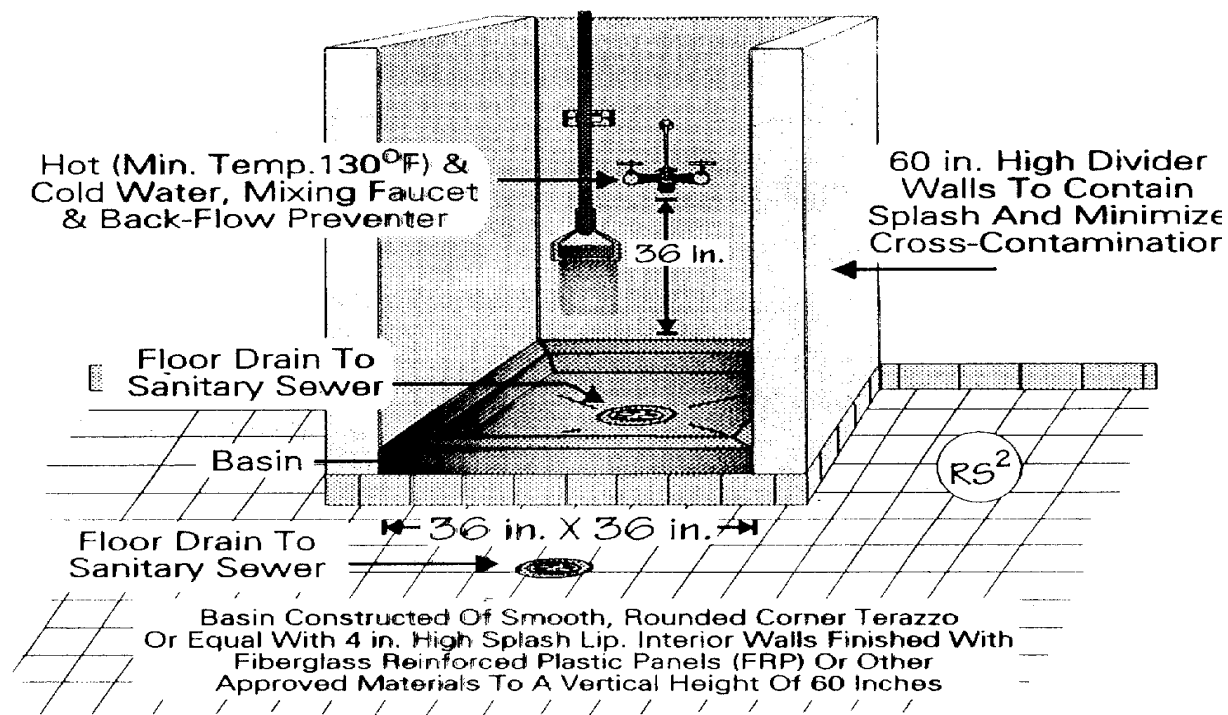
Air conditioning may also serve as a source of make-up air, with each ton of an air conditioning system supplying 400 CFM of outside air.

Reference: South Carolina Department of Health And Environmental Control, 2600 Bull Street, Columbia, South Carolina 29201, "Food Equipment Installation Manual"

## **SECTION 16 - CAN AND MOP CLEANING FACILITY**

A curbed can wash/mop basin with a floor drain shall be provided. Cleaning facilities shall include combination faucet, hot and cold water and threaded nozzle with appropriate backflow prevention device.

- A. If located inside the building, it may have combined use for cleaning mops and disposal of mop water or similar waste. Minimum recommended size is 3' x 3'.
- B. If located outside of the building, an additional mop basin for cleaning mops and disposal of mop water or similar waste may be required inside the building. Minimum recommended size for can wash is 3'x 3', minimum recommended size for mop basin is 2'x 2'. If chemical storage and hose reels are used in this area the unit will need to be increased in size to accommodate these additions . Minimum recommended size for can wash with chemical storage and hose reel is 3'x 4'.
- C. If located outside of the building some local municipal authorities may require the facility to be protected from rain water intrusion.
- D. Separate cleaning facilities may be required for portable food service equipment for catering operations.
- E. When food service equipment which will not be cleaned in place and is to be removed from the establishment then facilities shall be provided for cleaning and shall be approved prior to use. ( **Figure 19** illustrates a typical can wash area )



**Figure 19**

## **SECTION 17 - GARBAGE AND REFUSE STORAGE**

- A. All sewage and other liquid waste shall be disposed of in a public sewer system or in the absence of a public sewer system, by an approved properly operating sanitary sewage system.
- B. Garbage shall be collected and stored in standard, watertight garbage cans or other approved containers or methods and provided with tight-fitting lid. Lids shall be kept in place, except for cans inside the kitchen which are being used frequently during normal operation. The contents of these cans shall be removed frequently and the cans shall be washed.
- C. Garbage and trash, including recycling items and all other refuse resulting from the establishments operation and other sources, shall be removed from the building and premises as maybe necessary and disposed of in an approved manner.
- D. Facilities shall be provided for the cleaning and storage of all garbage, recycling containers, grease storage containers and mops.

### **Dumpster Pads, Recycle Containers and Facilities**

Cleaning facilities shall include a combination faucet, hot and cold or tempered water, threaded nozzle, and curbed impervious pad sloped to drain or other approved methods at the facility. (Contract cleaning of the dumpster may be permitted if contracted in writing.)

Where containerized systems (compactors) are used for garbage storage, facilities shall be provided for the cleaning of such systems. ( Contract cleaning of the containerized system may be permitted if contracted in writing.)

Cardboard storage containers shall be stored on concrete pads or other impervious surfaces so as to prevent rodent harborage. Dumpsters shall have drainage holes plugged when not being cleaned.

Water should be accessible to cleaning area and not over 50 feet away.

### **Dumpster, Compactor And Grease Pad Installation That Allows For On Site Cleaning Without Impacting The Sanitary Sewer System With Rain Water.**

Surface water restricting valves shall be used where Municipal Sewage Departments or on site sewage disposal system requires restriction of surface water.

The problem that has come up in many municipalities is that some will not allow for these drains to be installed for fear of rain water coming off the pad will overload the municipal sewage treatment system.

This can be avoided be installing a sump in the pad which has a double outlet. One outlet will allow for rain water to be discharged to the storm drain and the other outlet to drain directly into the sanitary sewer system with the use of a submersible trash pump. ( **Figure 20 illustrates such a concept** )

The concept behind this is when the dumpster is being washed an individual can turn on the switch to the pump and pump this liquid directly into the sanitary sewer system. When the cleaning operation is finished the switch is turned off and any rainwater that enters the sump will drain directly out into the storm drain. By installing this type of system two concerns are addressed; one being that the waste is now properly disposed of, and the other is satisfying the concern of excessive rain water impacting the municipal sewage treatment system.

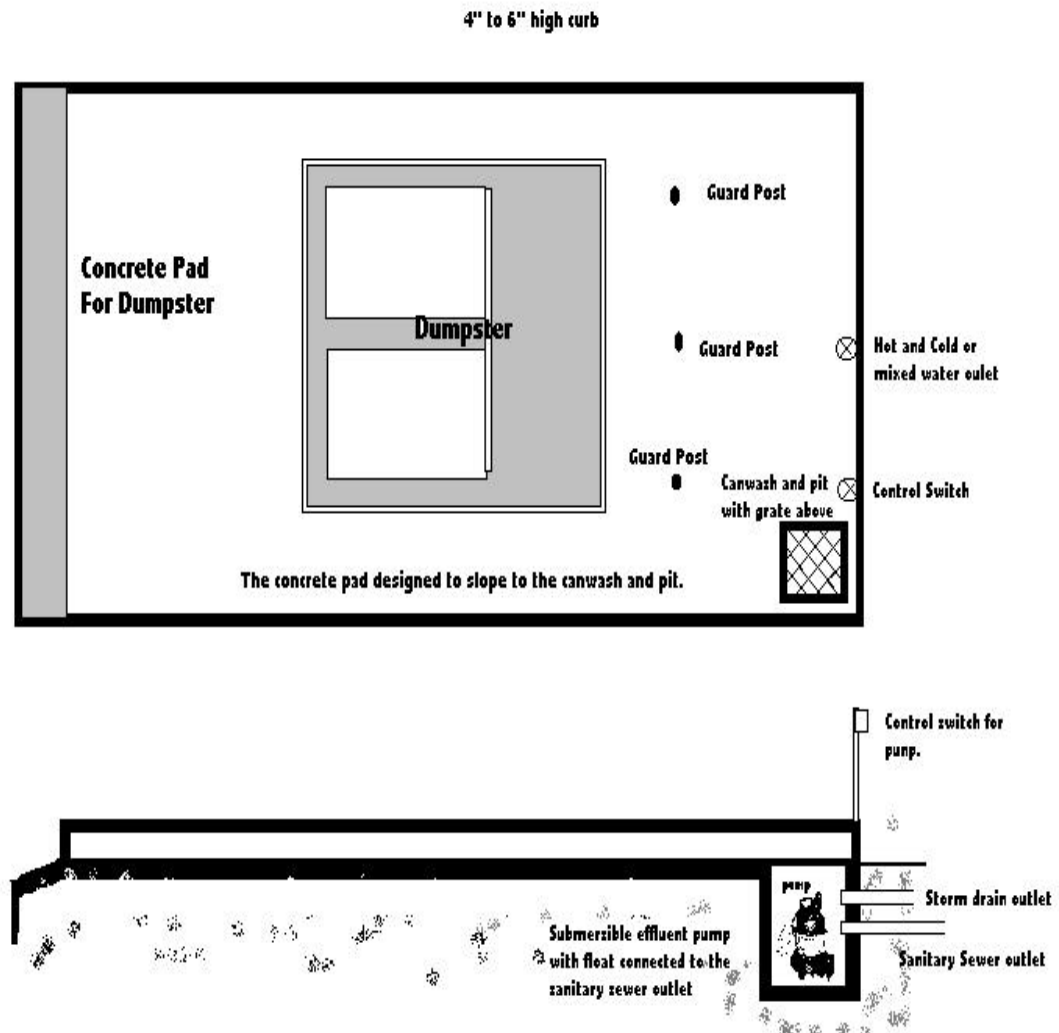


Figure 20

## **SECTION 18 - DRESSING ROOMS AND LOCKERS**

Rooms or areas separate from food preparation, storage or service areas, and separate from utensil washing or storage areas should be provided if employees will routinely change clothes within the establishment.

Lockers or other suitable storage facilities shall be located in dressing areas.

If dressing rooms are not provided, separate facilities shall be provided for coats, sweaters and other personal belongings.

## Appendix A-1. Facilities to Maintain Temperature Storage Charts For

### Meat And Poultry Cold Storage Chart For Walk-In And Walk-In Units

The following three charts are based on the volume of the meals, number of meals served and frequency of delivery.

To calculate the interior storage space required for walk-in refrigeration units for the following charts to square feet, simply divide the cu. ft. (volume), in each case by the height of the unit.

#### MEAT AND POULTRY COLD STORAGE CHART FOR WALK-IN UNITS

number of meals meals served between deliveries	storage per cu. ft. per 0.01 Cu. Ft. per meal per number meals served	storage per cu. ft. per 0.015 Cu. Ft. per meal per number meals served	storage per cu. ft. per 0.020 Cu. Ft. per meal per number meals served	storage per cu. ft. per 0.025 Cu. Ft. per meal per number meals served	storage per cu. ft. per 0.03 Cu. Ft. per meal per number meals served
200	5	7.50	10.00	12.50	15.00
250	6.25	9.38	12.50	15.63	18.75
300	7.50	11.25	15.00	18.75	22.50
350	8.75	13.13	17.50	21.88	26.25
400	10.00	15.00	20.00	25.00	30.00
450	11.25	16.88	22.50	28.13	33.75
500	12.50	18.75	25.00	31.25	37.50
550	13.75	20.63	27.50	34.38	41.25
600	15.00	22.50	30.00	37.50	45.00
650	16.25	24.38	32.50	40.63	48.75
700	17.50	26.25	35.00	43.75	52.50
750	18.75	28.13	37.50	46.88	56.25
800	20.00	30.00	40.00	50.00	60.00
850	21.25	31.88	42.50	53.13	63.75
900	22.50	33.75	45.00	56.25	67.50
950	23.75	35.63	47.50	59.38	71.25
1000	25.00	37.50	50.00	62.50	75.00

## MEAT AND POULTRY COLD STORAGE CHART FOR WALK-IN UNITS

number of meals served between deliveries	storage per cu. ft. per 0.01 Cu. Ft. per meal per number meals served	storage per cu. ft. per 0.015 Cu. Ft. per meal per number meals served	storage per cu. ft. per 0.020 Cu. Ft. per meal per number meals served	storage per cu. ft. per 0.025 Cu. Ft. per meal per number meals served	storage per cu. ft. per 0.03 Cu. Ft. per meal per number meals served
1050	26.25	39.38	52.50	65.63	78.75
1100	27.50	41.25	55.00	68.75	82.50
1150	28.75	43.13	57.50	71.88	86.25
1200	30.00	45.00	60.00	75.00	90.00
1250	31.25	46.88	62.50	78.13	93.75
1300	32.50	48.75	65.00	81.25	97.50
1350	33.75	50.63	67.50	84.38	101.25
1400	35.00	52.50	70.00	87.50	105.00
1450	36.25	54.38	72.50	90.63	108.75
1500	37.50	56.25	75.00	93.75	112.50
1550	38.75	58.13	77.50	96.88	116.25
1600	40.00	60.00	80.00	100.00	120.00
1650	41.25	61.88	82.50	103.13	123.75
1700	42.50	63.75	85.00	106.25	127.50
1750	43.75	65.63	87.50	109.38	131.25
1800	45.00	67.50	90.00	112.50	135.00
1850	46.25	69.38	92.50	115.63	138.75
1900	47.50	71.25	95.00	118.75	142.50
1950	48.75	73.13	97.50	121.88	146.25
2000	50.00	75.00	100.00	125.00	150.00

## Vegetable and Fruit Cold Storage Chart For Walk-In Units

number of meals served between deliveries	Storage per cu. ft. per 0.020 Cu. Ft. per meal per number meals served	storage per cu. ft. per 0.025 Cu. Ft. per meal per number meals served	storage per cu. ft. per 0.030 Cu. Ft. per meal per number meals served	storage per cu. ft. per 0.035 Cu. Ft. per meal per number meals served	storage per cu. ft. per 0.040 Cu. Ft. per meal per number meals served
200	10.00	12.50	15.00	17.50	20.00
250	12.50	15.63	18.75	21.88	25.00
300	15.00	18.75	22.50	26.25	30.00
350	17.50	21.88	26.25	30.63	35.00
400	20.00	25.00	30.00	35.00	40.00
450	22.50	28.13	33.75	39.38	45.00
500	25.00	31.25	37.50	43.75	50.00
550	27.50	34.38	41.25	48.13	55.00
600	30.00	37.50	45.00	52.50	60.00
650	32.50	40.63	48.75	56.88	65.00
700	35.00	43.75	52.50	61.25	70.00
750	37.50	46.88	56.25	65.63	75.00
800	40.00	50.00	60.00	70.00	80.00
850	42.50	53.13	63.75	74.38	85.00
900	45.00	56.25	67.50	78.75	90.00
950	47.50	59.38	71.25	83.13	95.00
1000	50.00	62.50	75.00	87.50	100.00

<b>Vegetable and Fruit Cold Storage Chart For Walk-In Units</b>					
number of meals served between deliveries	storage per cu. ft. per 0.020 Cu. Ft. per meal per number meals served	storage per cu. ft. per 0.025 Cu. Ft. per meal per number meals served	storage per cu. ft. per 0.030 Cu. Ft. per meal per number meals served	storage per cu. ft. per 0.035 Cu. Ft. per meal per number meals served	storage per cu. ft. per 0.040 Cu. Ft. per meal per number meals served
1050	52.50	65.63	78.75	91.88	105.00
1100	55.00	68.75	82.50	96.25	110.00
1150	57.50	71.88	86.25	100.63	115.00
1200	60.00	75.00	90.00	105.00	120.00
1250	62.50	78.13	93.75	109.38	125.00
1300	65.00	81.25	97.50	113.75	130.00
1350	67.50	84.38	101.25	118.13	135.00
1400	70.00	87.50	105.00	122.50	140.00
1450	72.50	90.63	108.75	126.88	145.00
1500	75.00	93.75	112.50	131.25	150.00
1550	77.50	96.88	116.25	135.63	155.00
1600	80.00	100.00	120.00	140.00	160.00
1650	82.50	103.13	123.75	144.38	165.00
1700	85.00	106.25	127.50	148.75	170.00
1750	87.50	109.38	131.25	153.13	175.00
1800	90.00	112.50	135.00	157.50	180.00
1850	92.50	115.63	138.75	161.88	185.00
1900	95.00	118.75	142.50	166.25	190.00
1950	97.50	121.88	146.25	170.63	195.00
2000	100.00	125.00	150.00	175.00	200.00

## DAIRY COLD STORAGE CHART FOR WALK-IN UNITS

number of meals served between deliveries	storage per cu. ft. per 0.007 Cu. Ft. per meal per number meals served	storage per cu. ft. per 0.009 Cu. Ft. per meal per number meals served	storage per cu. ft. per 0.011 Cu. Ft. per meal per number meals served	storage per cu. ft. per 0.013 Cu. Ft. per meal per number meals served	Storage per cu. ft. per 0.015 Cu. Ft. per meal per number meals served
200	3.50	4.50	5.50	6.50	7.50
250	4.38	5.63	6.88	8.13	9.38
300	5.25	6.75	8.25	9.75	11.25
350	6.13	7.88	9.63	11.38	13.13
400	7.00	9.00	11.00	13.00	15.00
450	7.88	10.13	12.38	14.63	16.88
500	8.75	11.25	13.75	16.25	18.75
550	9.63	12.38	15.13	17.88	20.63
600	10.50	13.50	16.50	19.50	22.50
650	11.38	14.63	17.88	21.13	24.38
700	12.25	15.75	19.25	22.75	26.25
750	13.13	16.88	20.63	24.38	28.13
800	14.00	18.00	22.00	26.00	30.00
850	14.88	19.13	23.38	27.63	31.88
900	15.75	20.25	24.75	29.25	33.75
950	16.63	21.38	26.13	30.88	35.63
1000	17.50	22.50	27.50	32.50	37.50

<b>DAIRY COLD STORAGE CHART FOR WALK-IN UNITS</b>					
number of meals served between deliveries	storage per cu. ft. per 0.007 Cu. Ft. per meal per number meals served	storage per cu. ft. per 0.009 Cu. Ft. per meal per number meals served	storage per cu. ft. per 0.011 Cu. Ft. per meal per number meals served	storage per cu. ft. per 0.013 Cu. Ft. per meal per number meals served	Storage per cu. ft. per 0.015 Cu. Ft. per meal per number meals served
1050	18.38	23.63	28.88	34.13	39.38
1100	19.25	24.75	30.25	35.75	41.25
1150	20.13	25.88	31.63	37.38	43.13
1200	21.00	27.00	33.00	39.00	45.00
1250	21.88	28.13	34.38	40.63	46.88
1300	22.75	29.25	35.75	42.25	48.75
1350	23.63	30.38	37.13	43.88	50.63
1400	24.50	31.50	38.50	45.50	52.50
1450	25.38	32.63	39.88	47.13	54.38
1500	26.25	33.75	41.25	48.75	56.25
1550	27.13	34.88	42.63	50.38	58.13
1600	28.00	36.00	44.00	52.00	60.00
1650	28.88	37.13	45.38	53.63	61.88
1700	29.75	38.25	46.75	55.25	63.75
1750	30.63	39.38	48.13	56.88	65.63
1800	31.50	40.50	49.50	58.50	67.50
1850	32.38	41.63	50.88	60.13	69.38
1900	33.25	42.75	52.25	61.75	71.25
1950	34.13	43.88	53.63	63.38	73.13
2000	35.00	45.00	55.00	65.00	75.00

## MEAT AND POULTRY COLD STORAGE CHART FOR REACH-IN UNITS

number of meals served between deliveries	storage per cu. ft. per 0.01 Cu. Ft. per meal per number meals served	storage per cu. ft. per 0.015 Cu. Ft. per meal per number meals served	storage per cu. ft. per 0.020 Cu. Ft. per meal per number meals served	storage per cu. ft. per 0.025 Cu. Ft. per meal per number meals served	storage per cu. ft. per 0.03 Cu. Ft. per meal per number meals served
200	2.67	4.00	5.33	6.67	8.00
250	3.33	5.00	6.67	8.33	10.00
300	4.00	6.00	8.00	10.00	12.00
350	4.67	7.00	9.33	11.67	14.00
400	5.33	8.00	10.67	13.33	16.00
450	6.00	9.00	12.00	15.00	18.00
500	6.67	10.00	13.33	16.67	20.00
550	7.33	11.00	14.67	18.33	22.00
600	8.00	12.00	16.00	20.00	24.00
650	8.67	13.00	17.33	21.67	26.00
700	9.33	14.00	18.67	23.33	28.00
750	10.00	15.00	20.00	25.00	30.00
800	10.67	16.00	21.33	26.67	32.00
850	11.33	17.00	22.67	28.33	34.00
900	12.00	18.00	24.00	30.00	36.00
950	12.67	19.00	25.33	31.67	38.00
1000	13.33	20.00	26.67	33.33	40.00

# MEAT AND POULTRY COLD STORAGE CHART FOR REACH-IN UNITS

number of meals served between deliveries	storage per cu. ft. per 0.01 Cu. Ft. per meal per number meals served	storage per cu. ft. per 0.015 Cu. Ft. per meal per number meals served	storage per cu. ft. per 0.020 Cu. Ft. per meal per number meals served	storage per cu. ft. per 0.025 Cu. Ft. per meal per number meals served	storage per cu. ft. per 0.03 Cu. Ft. per meal per number meals served
1050	14.00	21.00	28.00	35.00	42.00
1100	14.67	22.00	29.33	36.67	44.00
1150	15.33	23.00	30.67	38.33	46.00
1200	16.00	24.00	32.00	40.00	48.00
1250	16.67	25.00	33.33	41.67	50.00
1300	17.33	26.00	34.67	43.33	52.00
1350	18.00	27.00	36.00	45.00	54.00
1400	18.67	28.00	37.33	46.67	56.00
1450	19.33	29.00	38.67	48.33	58.00
1500	20.00	30.00	40.00	50.00	60.00
1550	20.67	31.00	41.33	51.67	62.00
1600	21.33	32.00	42.67	53.33	64.00
1650	22.00	33.00	44.00	55.00	66.00
1700	22.67	34.00	45.33	56.67	68.00
1750	23.33	35.00	46.67	58.33	70.00
1800	24.00	36.00	48.00	60.00	72.00
1850	24.67	37.00	49.33	61.67	74.00
1900	25.33	38.00	50.67	63.33	76.00
1950	26.00	39.00	52.00	65.00	78.00
2000	26.67	40.00	53.33	66.67	80.00

<b>Vegetable and Fruit Cold Storage Chart For Reach-In Units</b>					
number of meals served between deliveries	storage per cu. ft. per 0.020 Cu. Ft. per meal per number meals served	storage per cu. ft. per 0.025 Cu. Ft. per meal per number meals served	storage per cu. ft. per 0.030 Cu. Ft. per meal per number meals served	storage per cu. ft. per 0.035 Cu. Ft. per meal per number meals served	Storage per cu. ft. per 0.040 Cu. Ft. per meal per number meals served
200	5.33	6.67	8.00	9.33	10.67
250	6.67	8.33	10.00	11.67	13.33
300	8.00	10.00	12.00	14.00	16.00
350	9.33	11.67	14.00	16.33	18.67
400	10.67	13.33	16.00	18.67	21.33
450	12.00	15.00	18.00	21.00	24.00
500	13.33	16.67	20.00	23.33	26.67
550	14.67	18.33	22.00	25.67	29.33
600	16.00	20.00	24.00	28.00	32.00
650	17.33	21.67	26.00	30.33	34.67
700	18.67	23.33	28.00	32.67	37.33
750	20.00	25.00	30.00	35.00	40.00
800	21.33	26.67	32.00	37.33	42.67
850	22.67	28.33	34.00	39.67	45.33
900	24.00	30.00	36.00	42.00	48.00
950	25.33	31.67	38.00	44.33	50.67
1000	26.67	33.33	40.00	46.67	53.33

<b>Vegetable and Fruit Cold Storage Chart For Reach-In Units</b>					
number of meals served between deliveries	storage per cu. ft. per 0.020 Cu. Ft. per meal per number meals served	storage per cu. ft. per 0.025 Cu. Ft. per meal per number meals served	storage per cu. ft. per 0.030 Cu. Ft. per meal per number meals served	storage per cu. ft. per 0.035 Cu. Ft. per meal per number meals served	storage per cu. ft. per 0.040 Cu. Ft. per meal per number meals served
1050	28.00	35.00	42.00	49.00	56.00
1100	29.33	36.67	44.00	51.33	58.67
1150	30.67	38.33	46.00	53.67	61.33
1200	32.00	40.00	48.00	56.00	64.00
1250	33.33	41.67	50.00	58.33	66.67
1300	34.67	43.33	52.00	60.67	69.33
1350	36.00	45.00	54.00	63.00	72.00
1400	37.33	46.67	56.00	65.33	74.67
1450	38.67	48.33	58.00	67.67	77.33
1500	40.00	50.00	60.00	70.00	80.00
1550	41.33	51.67	62.00	72.33	82.67
1600	42.67	53.33	64.00	74.67	85.33
1650	44.00	55.00	66.00	77.00	88.00
1700	45.33	56.67	68.00	79.33	90.67
1750	46.67	58.33	70.00	81.67	93.33
1800	48.00	60.00	72.00	84.00	96.00
1850	49.33	61.67	74.00	86.33	98.67
1900	50.67	63.33	76.00	88.67	101.33
1950	52.00	65.00	78.00	91.00	104.00
2000	53.33	66.67	80.00	93.33	106.67

## DAIRY COLD STORAGE CHART FOR REACN- IN UNITS

number of meals served between deliveries	storage per cu. ft. per 0.007 Cu. Ft. per meal per number meals served	storage per cu. ft. per 0.009 Cu. Ft. per meal per number meals served	storage per cu. ft. per 0.011 Cu. Ft. per meal per number meals served	storage per cu. ft. per 0.013 Cu. Ft. per meal per number meals served	storage per cu. ft. per 0.015 Cu. Ft. per meal per number meals served
200	1.87	2.40	2.93	3.47	4.00
250	2.33	3.00	3.67	4.33	5.00
300	2.80	3.60	4.40	5.20	6.00
350	3.27	4.20	5.13	6.07	7.00
400	3.73	4.80	5.87	6.93	8.00
450	4.20	5.40	6.60	7.80	9.00
500	4.67	6.00	7.33	8.67	10.00
550	5.13	6.60	8.07	9.53	11.00
600	5.60	7.20	8.80	10.40	12.00
650	6.07	7.80	9.53	11.27	13.00
700	6.53	8.40	10.27	12.13	14.00
750	7.00	9.00	11.00	13.00	15.00
800	7.47	9.60	11.73	13.87	16.00
850	7.93	10.20	12.47	14.73	17.00
900	8.40	10.80	13.20	15.60	18.00
950	8.87	11.40	13.93	16.47	19.00
1000	9.33	12.00	14.67	17.33	20.00

<b>DAIRY COLD STORAGE CHART FOR REACN- IN UNITS</b>					
number of meals served between deliveries	storage per cu. ft. per 0.007 Cu. Ft. per meal per number meals served	storage per cu. ft. per 0.009 Cu. Ft. per meal per number meals served	storage per cu. ft. per 0.011 Cu. Ft. per meal per number meals served	storage per cu. ft. per 0.013 Cu. Ft. per meal per number meals served	storage per cu. ft. per 0.015 Cu. Ft. per meal per number meals served
1050	9.80	12.60	15.40	18.20	21.00
1100	10.27	13.20	16.13	19.07	22.00
1150	10.73	13.80	16.87	19.93	23.00
1200	11.20	14.40	17.60	20.80	24.00
1250	11.67	15.00	18.33	21.67	25.00
1300	12.13	15.60	19.07	22.53	26.00
1350	12.60	16.20	19.80	23.40	27.00
1400	13.07	16.80	20.53	24.27	28.00
1450	13.53	17.40	21.27	25.13	29.00
1500	14.00	18.00	22.00	26.00	30.00
1550	14.47	18.60	22.73	26.87	31.00
1600	14.93	19.20	23.47	27.73	32.00
1650	15.40	19.80	24.20	28.60	33.00
1700	15.87	20.40	24.93	29.47	34.00
1750	16.33	21.00	25.67	30.33	35.00
1800	16.80	21.60	26.40	31.20	36.00
1850	17.27	22.20	27.13	32.07	37.00
1900	17.73	22.80	27.87	32.93	38.00
1950	18.20	23.40	28.60	33.80	39.00
2000	18.67	24.00	29.33	34.67	40.00

### Section 3-A Dry Storage Consideration Charts

<b>Formula #1</b> <b>Dry Storage Chart # 1</b>				<b>Formula #1</b> <b>Dry Storage Chart # 2</b>			
calculated storage area per .025 cu. ft. per meal served Linear feet of storage shelf area need				Calculated storage area per .025 cu. ft. per meal served Linear feet of storage shelf area need			
Meals Served	1 ft. deep by 1ft high shelves	1 ft. deep by 18 inches high shelves	1 ft. deep by 2ft high shelves	Meals Served	1.5 ft. deep by 1ft high shelves	1.5 ft. deep by 18 inches high shelves	1.5 ft. deep by 2ft high shelves
200	6.25	4.17	3.13	200	4.17	2.78	2.08
250	7.81	5.21	3.91	250	5.21	3.47	2.60
300	9.38	6.25	4.69	300	6.25	4.17	3.13
350	10.94	7.29	5.47	350	7.29	4.86	3.65
400	12.50	8.33	6.25	400	8.33	5.56	4.17
450	14.06	9.38	7.03	450	9.38	6.25	4.69
500	15.63	10.42	7.81	500	10.42	6.94	5.21
550	17.19	11.46	8.59	550	11.46	7.64	5.73
600	18.75	12.50	9.38	600	12.50	8.33	6.25
650	20.31	13.54	10.16	650	13.54	9.03	6.77
700	21.88	14.58	10.94	700	14.58	9.72	7.29
750	23.44	15.63	11.72	750	15.63	10.42	7.81
800	25.00	16.67	12.50	800	16.67	11.11	8.33
850	26.56	17.71	13.28	850	17.71	11.81	8.85
900	28.13	18.75	14.06	900	18.75	12.50	9.38
950	29.69	19.79	14.84	950	19.79	13.19	9.90
1000	31.25	20.83	15.63	1000	20.83	13.89	10.42

<b>Formula #1</b> <b>Dry Storage Chart # 3</b>				<b>Formula #1</b> <b>Dry Storage Chart # 4</b>			
calculated storage area per .025 cu. ft. per meal served Linear feet of storage shelf area need				calculated storage area per .03 cu. ft. per meal served Linear feet of storage shelf area need			
Meals Served	2 ft. deep by 1ft high shelves	2 ft. deep by 18inches high shelves	2 ft. deep by 2ft high shelves	Meals Served	1 ft. deep by 1ft high shelves	1 ft. deep by 18 inches high shelves	1 ft. deep by 2ft high shelves
200	3.13	2.08	1.56	200	7.50	5.00	3.75
250	3.91	2.60	1.95	250	9.38	6.25	4.69
300	4.69	3.13	2.34	300	11.25	7.50	5.63
350	5.47	3.65	2.73	350	13.13	8.75	6.56
400	6.25	4.17	3.13	400	15.00	10.00	7.50
450	7.03	4.69	3.52	450	16.88	11.25	8.44
500	7.81	5.21	3.91	500	18.75	12.50	9.38
550	8.59	5.73	4.30	550	20.63	13.75	10.31
600	9.38	6.25	4.69	600	22.50	15.00	11.25
650	10.16	6.77	5.08	650	24.38	16.25	12.19
700	10.94	7.29	5.47	700	26.25	17.50	13.13
750	11.72	7.81	5.86	750	28.13	18.75	14.06
800	12.50	8.33	6.25	800	30.00	20.00	15.00
850	13.28	8.85	6.64	850	31.88	21.25	15.94
900	14.06	9.38	7.03	900	33.75	22.50	16.88
950	14.84	9.90	7.42	950	35.63	23.75	17.81
1000	15.63	10.42	7.81	1000	37.50	25.00	18.75

<b>Formula #1</b> <b>Dry Storage Chart # 5</b>				<b>Formula #1</b> <b>Dry Storage Chart #6</b>			
calculated storage area per .03 cu. ft. per meal served Linear feet of storage shelf area need				calculated storage area per .03 cu. ft. per meal served Linear feet of storage shelf area need			
Meals Served	1.5 ft. deep by 1ft high shelves	1.5 ft. deep by 18 inches high shelves	1.5 ft. deep by 2ft high shelves	Meals Served	2 ft. deep by 1ft high shelves	2 ft. deep by 18 inches high shelves	2 ft. deep by 2ft high shelves
200	5.00	3.33	2.50	200	3.75	2.50	1.88
250	6.25	4.17	3.13	250	4.69	3.13	2.34
300	7.50	5.00	3.75	300	5.63	3.75	2.81
350	8.75	5.83	4.38	350	6.56	4.38	3.28
400	10.00	6.67	5.00	400	7.50	5.00	3.75
450	11.25	7.50	5.63	450	8.44	5.63	4.22
500	12.50	8.33	6.25	500	9.38	6.25	4.69
550	13.75	9.17	6.88	550	10.31	6.88	5.16
600	15.00	10.00	7.50	600	11.25	7.50	5.63
650	16.25	10.83	8.13	650	12.19	8.13	6.09
700	17.50	11.67	8.75	700	13.13	8.75	6.56
750	18.75	12.50	9.38	750	14.06	9.38	7.03
800	20.00	13.33	10.00	800	15.00	10.00	7.50
850	21.25	14.17	10.63	850	15.94	10.63	7.97
900	22.50	15.00	11.25	900	16.88	11.25	8.44
950	23.75	15.83	11.88	950	17.81	11.88	8.91
1000	25.00	16.67	12.50	1000	18.75	12.50	9.38

<b>Formula #1</b> <b>Dry Storage Chart # 7</b>			
calculated storage area per .035 cu. ft. per meal served Linear feet of storage shelf area need			
Meals Served	1 ft. deep by 1ft high shelves	1 ft. deep by 18 inches high shelves	1 ft. deep by 2ft high shelves
200	8.75	5.83	4.38
250	10.94	7.29	5.47
300	13.13	8.75	6.56
350	15.31	10.21	7.66
400	17.50	11.67	8.75
450	19.69	13.13	9.84
500	21.88	14.58	10.94
550	24.06	16.04	12.03
600	26.25	17.50	13.13
650	28.44	18.96	14.22
700	30.63	20.42	15.31
750	32.81	21.88	16.41
800	35.00	23.33	17.50
850	37.19	24.79	18.59
900	39.38	26.25	19.69
950	41.56	27.71	20.78
1000	43.75	29.17	21.88

<b>Formula #1</b> <b>Dry Storage Chart # 8</b>			
calculated storage area per .035 cu. ft. per meal served Linear feet of storage shelf area need			
Meals Served	1.5 ft. deep by 1ft high shelves	1.5 ft. deep by 18 inches high shelves	1.5 ft. deep by 2ft high shelves
200	5.83	3.89	2.92
250	7.29	4.86	3.65
300	8.75	5.83	4.38
350	10.21	6.81	5.10
400	11.67	7.78	5.83
450	13.13	8.75	6.56
500	14.58	9.72	7.29
550	16.04	10.69	8.02
600	17.50	11.67	8.75
650	18.96	12.64	9.48
700	20.42	13.61	10.21
750	21.88	14.58	10.94
800	23.33	15.56	11.67
850	24.79	16.53	12.40
900	26.25	17.50	13.13
950	27.71	18.47	13.85
1000	29.17	19.44	14.58

<b>Formula #1</b> <b>Dry Storage Chart # 9</b>				<b>Formula #1</b> <b>Dry Storage Chart # 10</b>			
calculated storage area per .035 cu. ft. per meal served Linear feet of storage shelf area need				calculated storage area per .04 cu. ft. per meal served Linear feet of storage shelf area need			
Meals Served	2 ft. deep by 1ft high shelves	2 ft. deep by 18inches high shelves	2 ft. deep by 2ft high shelves	Meals Served	1 ft. deep by 1ft high shelves	1 ft. deep by 18 inches high shelves	1 ft. deep by 2ft high shelves
200	4.38	2.92	2.19	200	10.00	6.67	5.00
250	5.47	3.65	2.73	250	12.50	8.33	6.25
300	6.56	4.38	3.28	300	15.00	10.00	7.50
350	7.66	5.10	3.83	350	17.50	11.67	8.75
400	8.75	5.83	4.38	400	20.00	13.33	10.00
450	9.84	6.56	4.92	450	22.50	15.00	11.25
500	10.94	7.29	5.47	500	25.00	16.67	12.50
550	12.03	8.02	6.02	550	27.50	18.33	13.75
600	13.13	8.75	6.56	600	30.00	20.00	15.00
650	14.22	9.48	7.11	650	32.50	21.67	16.25
700	15.31	10.21	7.66	700	35.00	23.33	17.50
750	16.41	10.94	8.20	750	37.50	25.00	18.75
800	17.50	11.67	8.75	800	40.00	26.67	20.00
850	18.59	12.40	9.30	850	42.50	28.33	21.25
900	19.69	13.13	9.84	900	45.00	30.00	22.50
950	20.78	13.85	10.39	950	47.50	31.67	23.75
1000	21.88	14.58	10.94	1000	50.00	33.33	25.00

<b>Formula #1</b> <b>Dry Storage Chart # 11</b>				<b>Formula #1</b> <b>Dry Storage Chart # 12</b>			
calculated storage area per .04 cu. ft. per meal served Linear feet of storage shelf area need				calculated storage area per .04 cu. ft. per meal served Linear feet of storage shelf area need			
Meals Served	1.5 ft. deep by 1ft high shelves	1.5 ft. deep by 18 inches high shelves	1.5 ft. deep by 2ft high shelves	Meals Served	2 ft. deep by 1ft high shelves	2 ft. deep by 18 inches high shelves	2 ft. deep by 2ft high shelves
200	6.67	4.44	3.33	200	5.00	3.33	2.50
250	8.33	5.56	4.17	250	6.25	4.17	3.13
300	10.00	6.67	5.00	300	7.50	5.00	3.75
350	11.67	7.78	5.83	350	8.75	5.83	4.38
400	13.33	8.89	6.67	400	10.00	6.67	5.00
450	15.00	10.00	7.50	450	11.25	7.50	5.63
500	16.67	11.11	8.33	500	12.50	8.33	6.25
550	18.33	12.22	9.17	550	13.75	9.17	6.88
600	20.00	13.33	10.00	600	15.00	10.00	7.50
650	21.67	14.44	10.83	650	16.25	10.83	8.13
700	23.33	15.56	11.67	700	17.50	11.67	8.75
750	25.00	16.67	12.50	750	18.75	12.50	9.38
800	26.67	17.78	13.33	800	20.00	13.33	10.00
850	28.33	18.89	14.17	850	21.25	14.17	10.63
900	30.00	20.00	15.00	900	22.50	15.00	11.25
950	31.67	21.11	15.83	950	23.75	15.83	11.88
1000	33.33	22.22	16.67	1000	25.00	16.67	12.50

<b>Formula #1</b> <b>Dry Storage Chart # 13</b>				<b>Formula #1</b> <b>Dry Storage Chart # 14</b>			
calculated storage area per .045 cu. ft. per meal served Linear feet of storage shelf area need				calculated storage area per .045 cu. ft. per meal served Linear feet of storage shelf area need			
Meals Served	1 ft. deep by 1ft high shelves	1 ft. deep by 18 inches high shelves	1 ft. deep by 2ft high shelves	Meals Served	1.5 ft. deep by 1ft high shelves	1.5 ft. deep by 18 inches high shelves	1.5 ft. deep by 2ft high shelves
200	11.25	7.50	5.63	200	7.50	5.00	3.75
250	14.06	9.38	7.03	250	9.38	6.25	4.69
300	16.88	11.25	8.44	300	11.25	7.50	5.63
350	19.69	13.13	9.84	350	13.13	8.75	6.56
400	22.50	15.00	11.25	400	15.00	10.00	7.50
450	25.31	16.88	12.66	450	16.88	11.25	8.44
500	28.13	18.75	14.06	500	18.75	12.50	9.38
550	30.94	20.63	15.47	550	20.63	13.75	10.31
600	33.75	22.50	16.88	600	22.50	15.00	11.25
650	36.56	24.38	18.28	650	24.38	16.25	12.19
700	39.38	26.25	19.69	700	26.25	17.50	13.13
750	42.19	28.13	21.09	750	28.13	18.75	14.06
800	45.00	30.00	22.50	800	30.00	20.00	15.00
850	47.81	31.88	23.91	850	31.88	21.25	15.94
900	50.63	33.75	25.31	900	33.75	22.50	16.88
950	53.44	35.63	26.72	950	35.63	23.75	17.81
1000	56.25	37.50	28.13	1000	37.50	25.00	18.75

<b>Formula #1</b> <b>Dry Storage Chart # 15</b>				<b>Formula #1</b> <b>Dry Storage Chart # 16</b>			
calculated storage area per .045 cu. ft. per meal served Linear feet of storage shelf area need				Calculated storage area per .05 cu. ft. per meal served Linear feet of storage shelf area need			
Meals Served	2 ft. deep by 1ft high shelves	2 ft. deep by 18 inches high shelves	2 ft. deep by 2ft high shelves	Meals Served	1 ft. deep by 1ft high shelves	1 ft. deep by 18 inches high shelves	1 ft. deep by 2ft high shelves
200	5.63	3.75	2.81	200	12.50	8.33	6.25
250	7.03	4.69	3.52	250	15.63	10.42	7.81
300	8.44	5.63	4.22	300	18.75	12.50	9.38
350	9.84	6.56	4.92	350	21.88	14.58	10.94
400	11.25	7.50	5.63	400	25.00	16.67	12.50
450	12.66	8.44	6.33	450	28.13	18.75	14.06
500	14.06	9.38	7.03	500	31.25	20.83	15.63
550	15.47	10.31	7.73	550	34.38	22.92	17.19
600	16.88	11.25	8.44	600	37.50	25.00	18.75
650	18.28	12.19	9.14	650	40.63	27.08	20.31
700	19.69	13.13	9.84	700	43.75	29.17	21.88
750	21.09	14.06	10.55	750	46.88	31.25	23.44
800	22.50	15.00	11.25	800	50.00	33.33	25.00
850	23.91	15.94	11.95	850	53.13	35.42	26.56
900	25.31	16.88	12.66	900	56.25	37.50	28.13
950	26.72	17.81	13.36	950	59.38	39.58	29.69
1000	28.13	18.75	14.06	1000	62.50	41.67	31.25

<b>Formula #1</b> <b>Dry Storage Chart # 17</b>				<b>Formula #1</b> <b>Dry Storage Chart # 18</b>			
calculated storage area per .05 cu. ft. per meal served Linear feet of storage shelf area need				Calculated storage area per .05 cu. ft. per meal served Linear feet of storage shelf area need			
Meals Served	1.5 ft. deep by 1ft high shelves	1.5 ft. deep by 18 inches high shelves	1.5 ft. deep by 2ft high shelves	Meals Served	2 ft. deep by 1ft high shelves	2 ft. deep by 18 inches high shelves	2 ft. deep by 2ft high shelves
200	8.33	5.56	4.17	200	6.25	4.17	3.13
250	10.42	6.94	5.21	250	7.81	5.21	3.91
300	12.50	8.33	6.25	300	9.38	6.25	4.69
350	14.58	9.72	7.29	350	10.94	7.29	5.47
400	16.67	11.11	8.33	400	12.50	8.33	6.25
450	18.75	12.50	9.38	450	14.06	9.38	7.03
500	20.83	13.89	10.42	500	15.63	10.42	7.81
550	22.92	15.28	11.46	550	17.19	11.46	8.59
600	25.00	16.67	12.50	600	18.75	12.50	9.38
650	27.08	18.06	13.54	650	20.31	13.54	10.16
700	29.17	19.44	14.58	700	21.88	14.58	10.94
750	31.25	20.83	15.63	750	23.44	15.63	11.72
800	33.33	22.22	16.67	800	25.00	16.67	12.50
850	35.42	23.61	17.71	850	26.56	17.71	13.28
900	37.50	25.00	18.75	900	28.13	18.75	14.06
950	39.58	26.39	19.79	950	29.69	19.79	14.84
1000	41.67	27.78	20.83	1000	31.25	20.83	15.63

## Dry Storage Chart # 1 - Formula #2

calculated storage area per .025 cu. ft. per meal served						calculated storage area per .03 cu. ft. per meal served					
Meals Served	useful storeroom height	0.3 usable storeroom floor area	0.4 usable storeroom floor area	0.5 usable storeroom floor area	0.6 usable storeroom floor area	meals served	useful storeroom height	0.3 usable storeroom floor area	0.4 usable storeroom floor area	0.5 usable storeroom floor area	0.6 usable storeroom floor area
200	4	4.17	3.13	2.50	2.08	200	4	5.00	3.75	3.00	2.50
250	4	5.21	3.91	3.13	2.60	250	4	6.25	4.69	3.75	3.13
300	4	6.25	4.69	3.75	3.13	300	4	7.50	5.63	4.50	3.75
350	4	7.29	5.47	4.38	3.65	350	4	8.75	6.56	5.25	4.38
400	4	8.33	6.25	5.00	4.17	400	4	10.00	7.50	6.00	5.00
450	4	9.38	7.03	5.63	4.69	450	4	11.25	8.44	6.75	5.63
500	4	10.42	7.81	6.25	5.21	500	4	12.50	9.38	7.50	6.25
550	4	11.46	8.59	6.88	5.73	550	4	13.75	10.31	8.25	6.88
600	4	12.50	9.38	7.50	6.25	600	4	15.00	11.25	9.00	7.50
650	4	13.54	10.16	8.13	6.77	650	4	16.25	12.19	9.75	8.13
700	4	14.58	10.94	8.75	7.29	700	4	17.50	13.13	10.50	8.75
750	4	15.63	11.72	9.38	7.81	750	4	18.75	12.00	11.25	9.38
800	4	16.67	12.50	10.00	8.33	800	4	20.00	15.00	12.00	10.00
850	4	17.71	13.28	10.63	8.85	850	4	21.25	15.94	12.75	10.63
900	4	18.75	14.06	11.25	9.38	900	4	22.50	16.88	13.50	11.25
950	4	19.79	14.84	11.88	9.90	950	4	23.75	17.81	14.25	11.88
1000	4	20.83	15.63	12.50	10.42	1000	4	25.00	18.75	15.00	12.50

## Dry Storage Chart # 2 - Formula #2

calculated storage area per .04 cu. ft. per meal served						calculated storage area per .04 cu. ft. per meal served					
meals served	useful storeroom height	0.3 usable storeroom floor area	0.4 usable storeroom floor area	0.5 usable storeroom floor area	0.6 usable storeroom floor area	meals served	useful storeroom height	0.3 usable storeroom floor area	0.4 usable storeroom floor area	0.5 usable storeroom floor area	0.6 usable storeroom floor area
200	4	5.83	4.38	3.50	2.92	200	4	6.67	5.00	4.00	3.33
250	4	7.29	5.47	4.38	3.65	250	4	8.33	6.25	5.00	4.17
300	4	8.75	6.56	5.25	4.38	300	4	10.00	7.50	6.00	5.00
350	4	10.21	7.66	6.13	5.10	350	4	11.67	8.75	7.00	5.83
400	4	11.67	8.75	7.00	5.83	400	4	13.33	10.00	8.00	6.67
450	4	13.13	9.84	7.88	6.56	450	4	15.00	11.25	9.00	7.50
500	4	14.58	10.94	8.75	7.29	500	4	16.67	12.50	10.00	8.33
550	4	16.04	12.03	9.63	8.02	550	4	18.33	13.75	11.00	9.17
600	4	17.50	13.13	10.50	8.75	600	4	20.00	15.00	12.00	10.00
650	4	18.96	14.22	11.38	9.48	650	4	21.67	16.25	13.00	10.83
700	4	20.42	15.31	12.25	10.21	700	4	23.33	17.50	14.00	11.67
750	4	21.88	16.41	13.13	10.94	750	4	25.00	18.75	15.00	12.50
800	4	23.33	17.50	14.00	11.67	800	4	26.67	20.00	16.00	13.33
850	4	24.79	18.59	14.88	12.40	850	4	28.33	21.25	17.00	14.17
900	4	26.25	19.69	15.75	13.13	900	4	30.00	22.50	18.00	15.00
950	4	27.71	20.78	16.63	13.85	950	4	31.67	23.75	19.00	15.83
1000	4	29.17	21.88	17.50	14.58	1000	4	33.33	25.00	20.00	16.67

### Dry Storage Chart # 3 - Formula #2

calculated storage area per .045 cu. ft. per meal served						calculated storage area per .05 cu. ft. per meal served					
meals served	useful storeroom height	0.3 usable storeroom floor area	0.4 usable storeroom floor area	0.5 usable storeroom floor area	0.6 usable storeroom floor area	meals served	useful storeroom height	0.3 usable storeroom floor area	0.4 usable storeroom floor area	0.5 usable storeroom floor area	0.6 usable storeroom floor area
200	4	7.50	5.63	4.50	3.75	200	4	8.33	6.25	5.00	4.17
250	4	9.38	7.03	5.63	4.69	250	4	10.42	7.81	6.25	5.21
300	4	11.25	8.44	6.75	5.63	300	4	12.50	9.38	7.50	6.25
350	4	13.13	9.84	7.88	6.56	350	4	14.58	10.94	8.75	7.29
400	4	15.00	11.25	9.00	7.50	400	4	16.67	12.50	10.00	8.33
450	4	16.88	12.66	10.13	8.44	450	4	18.75	14.06	11.25	9.38
500	4	18.75	14.06	11.25	9.38	500	4	20.83	15.63	12.50	10.42
550	4	20.63	15.47	12.38	10.31	550	4	22.92	17.19	13.75	11.46
600	4	22.50	16.88	13.50	11.25	600	4	25.00	18.75	15.00	12.50
650	4	24.38	18.28	14.63	12.19	650	4	27.08	20.31	16.25	13.54
700	4	26.25	19.69	15.75	13.13	700	4	29.17	21.88	17.50	14.58
750	4	28.13	21.09	16.88	14.06	750	4	31.25	23.44	18.75	15.63
800	4	30.00	22.50	18.00	15.00	800	4	33.33	25.00	20.00	16.67
850	4	31.88	23.91	19.13	15.94	850	4	35.42	26.56	21.25	17.71
900	4	33.75	25.31	20.25	16.88	900	4	37.50	28.13	22.50	18.75
950	4	35.63	26.72	21.38	17.81	950	4	39.58	29.69	23.75	19.79
1000	4	37.50	28.13	22.50	18.75	1000	4	41.67	31.25	25.00	20.83

## Dry Storage Chart # 4 - Formula #2

calculated storage area per .025 cu. ft. per meal served						calculated storage area per .03 cu. ft. per meal served					
meals served	useful storeroom height	0.3 usable storeroom floor area	0.4 usable storeroom floor area	0.5 usable storeroom floor area	0.6 usable storeroom floor area	meals served	useful storeroom height	0.3 usable storeroom floor area	0.4 usable storeroom floor area	0.5 usable storeroom floor area	0.6 usable storeroom floor area
200	5	3.33	2.50	2.00	1.67	200	5	4.00	3.00	2.40	2.00
250	5	4.17	3.13	2.50	2.08	250	5	5.00	3.75	3.00	2.50
300	5	5.00	3.75	3.00	2.50	300	5	6.00	4.50	3.60	3.00
350	5	5.83	4.38	3.50	2.92	350	5	7.00	5.25	4.20	3.50
400	5	6.67	5.00	4.00	3.33	400	5	8.00	6.00	4.80	4.00
450	5	7.50	5.63	4.50	3.75	450	5	9.00	6.75	5.40	4.50
500	5	8.33	6.25	5.00	4.17	500	5	10.00	7.50	6.00	5.00
550	5	9.17	6.88	5.50	4.58	550	5	11.00	8.25	6.60	5.50
600	5	10.00	7.50	6.00	5.00	600	5	12.00	9.00	7.20	6.00
650	5	10.83	8.13	6.50	5.42	650	5	13.00	9.75	7.80	6.50
700	5	11.67	8.75	7.00	5.83	700	5	14.00	10.50	8.40	7.00
750	5	12.50	9.38	7.50	6.25	750	5	15.00	11.25	9.00	7.50
800	5	13.33	10.00	8.00	6.67	800	5	16.00	12.00	9.60	8.00
850	5	14.17	10.63	8.50	7.08	850	5	17.00	12.75	10.20	8.50
900	5	15.00	11.25	9.00	7.50	900	5	18.00	13.50	10.80	9.00
950	5	15.83	11.88	9.50	7.92	950	5	19.00	14.25	11.40	9.50
1000	5	16.67	12.50	10.00	8.33	1000	5	20.00	15.00	12.00	10.00

## Dry Storage Chart # 5 - Formula #2

calculated storage area per .035 cu. ft. per meal served						calculated storage area per .04 cu. ft. per meal served					
meals served	useful storeroom height	0.3 usable storeroom floor area	0.4 usable storeroom floor area	0.5 usable storeroom floor area	0.6 usable storeroom floor area	meals served	useful storeroom height	0.3 usable storeroom floor area	0.4 usable storeroom floor area	0.5 usable storeroom floor area	0.6 usable storeroom floor area
200	5	4.67	3.50	2.80	2.33	200	5	5.33	4.00	3.20	2.67
250	5	5.83	4.38	3.50	2.92	250	5	6.67	5.00	4.00	3.33
300	5	7.00	5.25	4.20	3.50	300	5	8.00	6.00	4.80	4.00
350	5	8.17	6.13	4.90	4.08	350	5	9.33	7.00	5.60	4.67
400	5	9.33	7.00	5.60	4.67	400	5	10.67	8.00	6.40	5.33
450	5	10.50	7.88	6.30	5.25	450	5	12.00	9.00	7.20	6.00
500	5	11.67	8.75	7.00	5.83	500	5	13.33	10.00	8.00	6.67
550	5	12.83	9.63	7.70	6.42	550	5	14.67	11.00	8.80	7.33
600	5	14.00	10.50	8.40	7.00	600	5	16.00	12.00	9.60	8.00
650	5	15.17	11.38	9.10	7.58	650	5	17.33	13.00	10.40	8.67
700	5	16.33	12.25	9.80	8.17	700	5	18.67	14.00	11.20	9.33
750	5	17.50	13.13	10.50	8.75	750	5	20.00	15.00	12.00	10.00
800	5	18.67	14.00	11.20	9.33	800	5	21.33	16.00	12.80	10.67
850	5	19.83	14.88	11.90	9.92	850	5	22.67	17.00	13.60	11.33
900	5	21.00	15.75	12.60	10.50	900	5	24.00	18.00	14.40	12.00
950	5	22.17	16.63	13.30	11.08	950	5	25.33	19.00	15.20	12.67
1000	5	23.33	17.50	14.00	11.67	1000	5	26.67	20.00	16.00	13.33

## Dry Storage Chart # 6 - Formula #2

calculated storage area per .045 cu. ft. per meal served						calculated storage area per .05 cu. ft. per meal served					
meals served	useful storeroom height	0.3 usable storeroom floor area	0.4 usable storeroom floor area	0.5 usable storeroom floor area	0.6 usable storeroom floor area	meals served	useful storeroom height	0.3 usable storeroom floor area	0.4 usable storeroom floor area	0.5 usable storeroom floor area	0.6 usable storeroom floor area
200	5	6.00	4.50	3.60	3.00	200	5	6.67	5.00	4.00	3.33
250	5	7.50	5.63	4.50	3.75	250	5	8.33	6.25	5.00	4.17
300	5	9.00	6.75	5.40	4.50	300	5	10.00	7.50	6.00	5.00
350	5	10.50	7.88	6.30	5.25	350	5	11.67	8.75	7.00	5.83
400	5	12.00	9.00	7.20	6.00	400	5	13.33	10.00	8.00	6.67
450	5	13.50	10.13	8.10	6.75	450	5	15.00	11.25	9.00	7.50
500	5	15.00	11.25	9.00	7.50	500	5	16.67	12.50	10.00	8.33
550	5	16.50	12.38	9.90	8.25	550	5	18.33	13.75	11.00	9.17
600	5	18.00	13.50	10.80	9.00	600	5	20.00	15.00	12.00	10.00
650	5	19.50	14.63	11.70	9.75	650	5	21.67	16.25	13.00	10.83
700	5	21.00	15.75	12.60	10.50	700	5	23.33	17.50	14.00	11.67
750	5	22.50	16.88	13.50	11.25	750	5	25.00	18.75	15.00	12.50
800	5	24.00	18.00	14.40	12.00	800	5	26.67	20.00	16.00	13.33
850	5	25.50	19.13	15.30	12.75	850	5	28.33	21.25	17.00	14.17
900	5	27.00	20.25	16.20	13.50	900	5	30.00	22.50	18.00	15.00
950	5	28.50	21.38	17.10	14.25	950	5	31.67	23.75	19.00	15.83
1000	5	30.00	22.50	18.00	15.00	1000	5	33.33	25.00	20.00	16.67

## Dry Storage Chart # 7 - Formula #2

calculated storage area per .025 cu. ft. per meal served						calculated storage area per .03 cu. ft. per meal served					
meals served	useful storeroom height	0.3 usable storeroom floor area	0.4 usable storeroom floor area	0.5 usable storeroom floor area	0.6 usable storeroom floor area	meals served	useful storeroom height	0.3 usable storeroom floor area	0.4 usable storeroom floor area	0.5 usable storeroom floor area	0.6 usable storeroom floor area
200	6	2.78	2.08	1.67	1.39	200	6	3.33	2.50	2.00	1.67
250	6	3.47	2.60	2.08	1.74	250	6	4.17	3.13	2.50	2.08
300	6	4.17	3.13	2.50	2.08	300	6	5.00	3.75	3.00	2.50
350	6	4.86	3.65	2.92	2.43	350	6	5.83	4.38	3.50	2.92
400	6	5.56	4.17	3.33	2.78	400	6	6.67	5.00	4.00	3.33
450	6	6.25	4.69	3.75	3.13	450	6	7.50	5.63	4.50	3.75
500	6	6.94	5.21	4.17	3.47	500	6	8.33	6.25	5.00	4.17
550	6	7.64	5.73	4.58	3.82	550	6	9.17	6.88	5.50	4.58
600	6	8.33	6.25	5.00	4.17	600	6	10.00	7.50	6.00	5.00
650	6	9.03	6.77	5.42	4.51	650	6	10.83	8.13	6.50	5.42
700	6	9.72	7.29	5.83	4.86	700	6	11.67	8.75	7.00	5.83
750	6	10.42	7.81	6.25	5.21	750	6	12.50	9.38	7.50	6.25
800	6	11.11	8.33	6.67	5.56	800	6	13.33	10.00	8.00	6.67
850	6	11.81	8.85	7.08	5.90	850	6	14.17	10.63	8.50	7.08
900	6	12.50	9.38	7.50	6.25	900	6	15.00	11.25	9.00	7.50
950	6	13.19	9.90	7.92	6.60	950	6	15.83	11.88	9.50	7.92
1000	6	13.89	10.42	8.33	6.94	1000	6	16.67	12.50	10.00	8.33

## Dry Storage Chart # 8 - Formula #2

calculated storage area per .035 cu. ft. per meal served						calculated storage area per .04 cu. ft. per meal served					
meals served	useful storeroom height	0.3 usable storeroom floor area	0.4 usable storeroom floor area	0.5 usable storeroom floor area	0.6 usable storeroom floor area	meals served	useful storeroom height	0.3 usable storeroom floor area	0.4 usable storeroom floor area	0.5 usable storeroom floor area	0.6 usable storeroom floor area
200	6	3.89	2.92	2.33	1.94	200	6	4.44	3.33	2.67	2.22
250	6	4.86	3.65	2.92	2.43	250	6	5.56	4.17	3.33	2.78
300	6	5.83	4.38	3.50	2.92	300	6	6.67	5.00	4.00	3.33
350	6	6.81	5.10	4.08	3.40	350	6	7.78	5.83	4.67	3.89
400	6	7.78	5.83	4.67	3.89	400	6	8.89	6.67	5.33	4.44
450	6	8.75	6.56	5.25	4.38	450	6	10.00	7.50	6.00	5.00
500	6	9.72	7.29	5.83	4.86	500	6	11.11	8.33	6.67	5.56
550	6	10.69	8.02	6.42	5.35	550	6	12.22	9.17	7.33	6.11
600	6	11.67	8.75	7.00	5.83	600	6	13.33	10.00	8.00	6.67
650	6	12.64	9.48	7.58	6.32	650	6	14.44	10.83	8.67	7.22
700	6	13.61	10.21	8.17	6.81	700	6	15.56	11.67	9.33	7.78
750	6	14.58	10.94	8.75	7.29	750	6	16.67	12.50	10.00	8.33
800	6	15.56	11.67	9.33	7.78	800	6	17.78	13.33	10.67	8.89
850	6	16.53	12.40	9.92	8.26	850	6	18.89	14.17	11.33	9.44
900	6	17.50	13.13	10.50	8.75	900	6	20.00	15.00	12.00	10.00
950	6	18.47	13.85	11.08	9.24	950	6	21.11	15.83	12.67	10.56
1000	6	19.44	14.58	11.67	9.72	1000	6	22.22	16.67	13.33	11.11

## Dry Storage Chart # 9 - Formula #2

calculated storage area per .045 cu. ft. per meal served						calculated storage area per .05 cu. ft. per meal served					
meals served	useful storeroom height	0.3 usable storeroom floor area	0.4 usable storeroom floor area	0.5 usable storeroom floor area	0.6 usable storeroom floor area	meals served	useful storeroom height	0.3 usable storeroom floor area	0.4 usable storeroom floor area	0.5 usable storeroom floor area	0.6 usable storeroom floor area
200	6	5.00	3.75	3.00	2.50	200	6	5.56	4.17	3.33	2.78
250	6	6.25	4.69	3.75	3.13	250	6	6.94	5.21	4.17	3.47
300	6	7.50	5.63	4.50	3.75	300	6	8.33	6.25	5.00	4.17
350	6	8.75	6.56	5.25	4.38	350	6	9.72	7.29	5.83	4.86
400	6	10.00	7.50	6.00	5.00	400	6	11.11	8.33	6.67	5.56
450	6	11.25	8.44	6.75	5.63	450	6	12.50	9.38	7.50	6.25
500	6	12.50	9.38	7.50	6.25	500	6	13.89	10.42	8.33	6.94
550	6	13.75	10.31	8.25	6.88	550	6	15.28	11.46	9.17	7.64
600	6	15.00	11.25	9.00	7.50	600	6	16.67	12.50	10.00	8.33
650	6	16.25	12.19	9.75	8.13	650	6	18.06	13.54	10.83	9.03
700	6	17.50	13.13	10.50	8.75	700	6	19.44	14.58	11.67	9.72
750	6	18.75	14.06	11.25	9.38	750	6	20.83	15.63	12.50	10.42
800	6	20.00	15.00	12.00	10.00	800	6	22.22	16.67	13.33	11.11
850	6	21.25	15.94	12.75	10.63	850	6	23.61	17.71	14.17	11.81
900	6	22.50	16.88	13.50	11.25	900	6	25.00	18.75	15.00	12.50
950	6	23.75	17.81	14.25	11.88	950	6	26.39	19.79	15.83	13.19
1000	6	25.00	18.75	15.00	12.50	1000	6	27.78	20.83	16.67	13.89

## Dry Storage Chart # 10 - Formula #2

calculated storage area per .025 cu. ft. per meal served						calculated storage area per .03 cu. ft. per meal served					
meals served	useful storeroom height	0.3 usable storeroom floor area	0.4 usable storeroom floor area	0.5 usable storeroom floor area	0.6 usable storeroom floor area	meals served	useful storeroom height	0.3 usable storeroom floor area	0.4 usable storeroom floor area	0.5 usable storeroom floor area	0.6 usable storeroom floor area
200	7	2.38	1.79	1.43	1.19	200	7	2.86	2.14	1.71	1.43
250	7	2.98	2.23	1.79	1.49	250	7	3.57	2.68	2.14	1.79
300	7	3.57	2.68	2.14	1.79	300	7	4.29	3.21	2.57	2.14
350	7	4.17	3.13	2.50	2.08	350	7	5.00	3.75	3.00	2.50
400	7	4.76	3.57	2.86	2.38	400	7	5.71	4.29	3.43	2.86
450	7	5.36	4.02	3.21	2.68	450	7	6.43	4.82	3.86	3.21
500	7	5.95	4.46	3.57	2.98	500	7	7.14	5.36	4.29	3.57
550	7	6.55	4.91	3.93	3.27	550	7	7.86	5.89	4.71	3.93
600	7	7.14	5.36	4.29	3.57	600	7	8.57	6.43	5.14	4.29
650	7	7.74	5.80	4.64	3.87	650	7	9.29	6.96	5.57	4.64
700	7	8.33	6.25	5.00	4.17	700	7	10.00	7.50	6.00	5.00
750	7	8.93	6.70	5.36	4.46	750	7	10.71	8.04	6.43	5.36
800	7	9.52	7.14	5.71	4.76	800	7	11.43	8.57	6.86	5.71
850	7	10.12	7.59	6.07	5.06	850	7	12.14	9.11	7.29	6.07
900	7	10.71	8.04	6.43	5.36	900	7	12.86	9.64	7.71	6.43
950	7	11.31	8.48	6.79	5.65	950	7	13.57	10.18	8.14	6.79
1000	7	11.90	8.93	7.14	5.95	1000	7	14.29	10.71	8.57	7.14

## Dry Storage Chart # 11 - Formula #2

calculated storage area per .035 cu. ft. per meal served						calculated storage area per .04 cu. ft. per meal served					
meals served	useful storeroom height	0.3 usable storeroom floor area	0.4 usable storeroom floor area	0.5 usable storeroom floor area	0.6 usable storeroom floor area	meals served	useful storeroom height	0.3 usable storeroom floor area	0.4 usable storeroom floor area	0.5 usable storeroom floor area	0.6 usable storeroom floor area
200	7	3.33	2.50	2.00	1.67	200	7	3.81	2.86	2.29	1.90
250	7	4.17	3.13	2.50	2.08	250	7	4.76	3.57	2.86	2.38
300	7	5.00	3.75	3.00	2.50	300	7	5.71	4.29	3.43	2.86
350	7	5.83	4.38	3.50	2.92	350	7	6.67	5.00	4.00	3.33
400	7	6.67	5.00	4.00	3.33	400	7	7.62	5.71	4.57	3.81
450	7	7.50	5.63	4.50	3.75	450	7	8.57	6.43	5.14	4.29
500	7	8.33	6.25	5.00	4.17	500	7	9.52	7.14	5.71	4.76
550	7	9.17	6.88	5.50	4.58	550	7	10.48	7.86	6.29	5.24
600	7	10.00	7.50	6.00	5.00	600	7	11.43	8.57	6.86	5.71
650	7	10.83	8.13	6.50	5.42	650	7	12.38	9.29	7.43	6.19
700	7	11.67	8.75	7.00	5.83	700	7	13.33	10.00	8.00	6.67
750	7	12.50	9.38	7.50	6.25	750	7	14.29	10.71	8.57	7.14
800	7	13.33	10.00	8.00	6.67	800	7	15.24	11.43	9.14	7.62
850	7	14.17	10.63	8.50	7.08	850	7	16.19	12.14	9.71	8.10
900	7	15.00	11.25	9.00	7.50	900	7	17.14	12.86	10.29	8.57
950	7	15.83	11.88	9.50	7.92	950	7	18.10	13.57	10.86	9.05
1000	7	16.67	12.50	10.00	8.33	1000	7	19.05	14.29	11.43	9.52

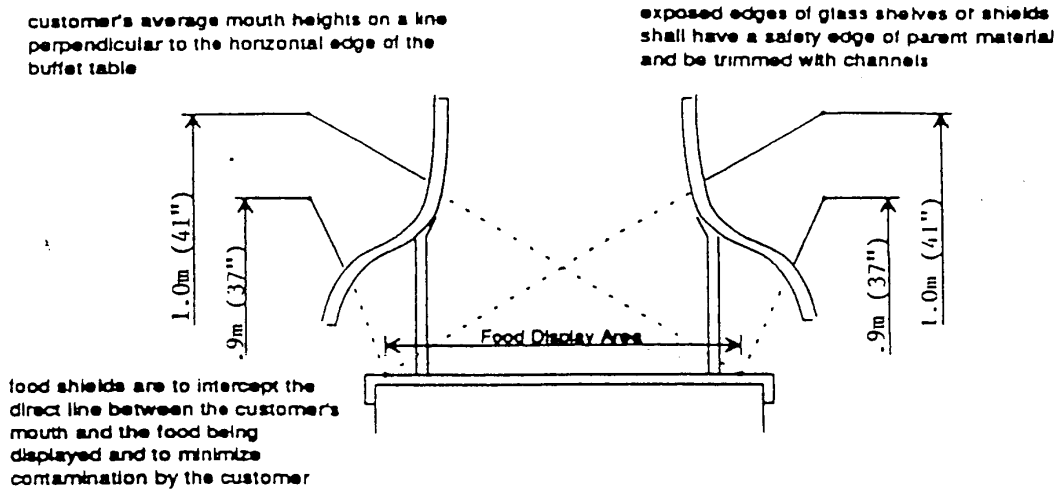
## Dry Storage Chart # 12 - Formula #2

calculated storage area per .045 cu. ft. per meal served						calculated storage area per .05 cu. ft. per meal served					
meals served	useful storeroom height	0.3 usable storeroom floor area	0.4 usable storeroom floor area	0.5 usable storeroom floor area	0.6 usable storeroom floor area	meals served	useful storeroom height	0.3 usable storeroom floor area	0.4 usable storeroom floor area	0.5 usable storeroom floor area	0.6 usable storeroom floor area
200	7	4.29	3.21	2.57	2.14	200	7	4.76	3.57	2.86	2.38
250	7	5.36	4.02	3.21	2.68	250	7	5.95	4.46	3.57	2.98
300	7	6.43	4.82	3.86	3.21	300	7	7.14	5.36	4.29	3.57
350	7	7.50	5.63	4.50	3.75	350	7	8.33	6.25	5.00	4.17
400	7	8.57	6.43	5.14	4.29	400	7	9.52	7.14	5.71	4.76
450	7	9.64	7.23	5.79	4.82	450	7	10.71	8.04	6.43	5.36
500	7	10.71	8.04	6.43	5.36	500	7	11.90	8.93	7.14	5.95
550	7	11.79	8.84	7.07	5.89	550	7	13.10	9.82	7.86	6.55
600	7	12.86	9.64	7.71	6.43	600	7	14.29	10.71	8.57	7.14
650	7	13.93	10.45	8.36	6.96	650	7	15.48	11.61	9.29	7.74
700	7	15.00	11.25	9.00	7.50	700	7	16.67	12.50	10.00	8.33
750	7	16.07	12.05	9.64	8.04	750	7	17.86	13.39	10.71	8.93
800	7	17.14	12.86	10.29	8.57	800	7	19.05	14.29	11.43	9.52
850	7	18.21	13.66	10.93	9.11	850	7	20.24	15.18	12.14	10.12
900	7	19.29	14.46	11.57	9.64	900	7	21.43	16.07	12.86	10.71
950	7	20.36	15.27	12.21	10.18	950	7	22.62	16.96	13.57	11.31
1000	7	21.43	16.07	12.86	10.71	1000	7	23.81	17.86	14.29	11.90

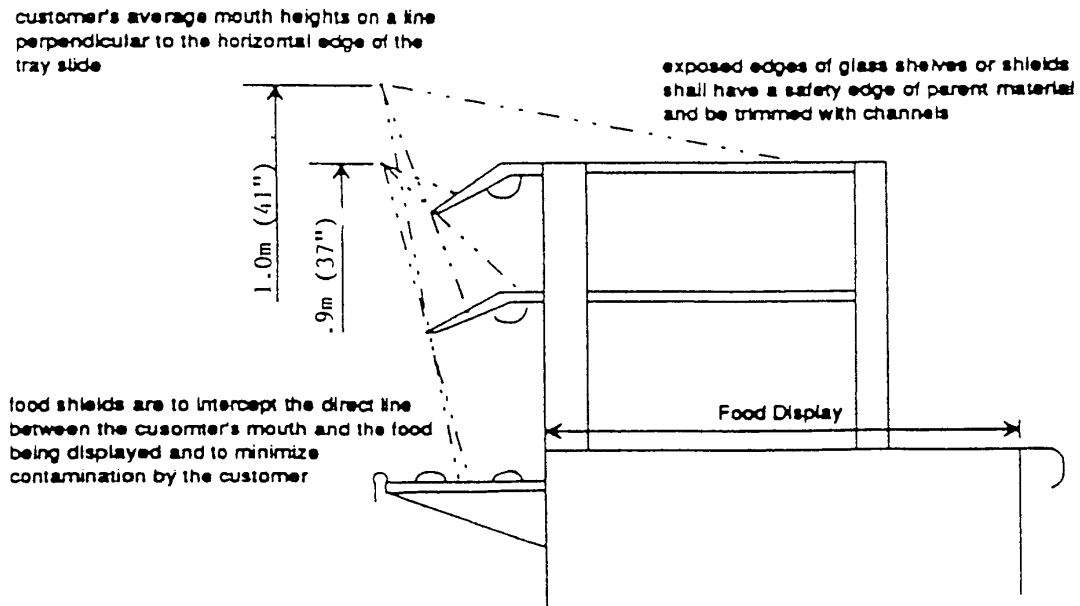
See Appendix A - 6 Sneeze Guard Design And Installation For Elementary, Middle, High School And For Commercial Food Service Establishments.

## Grades K-2

TYPICAL BUFFET TABLE



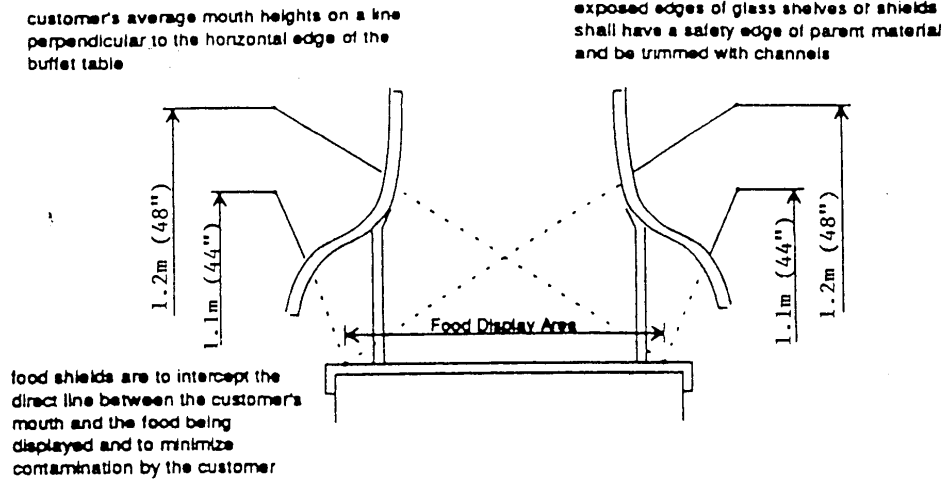
TYPICAL CAFETERIA COUNTER



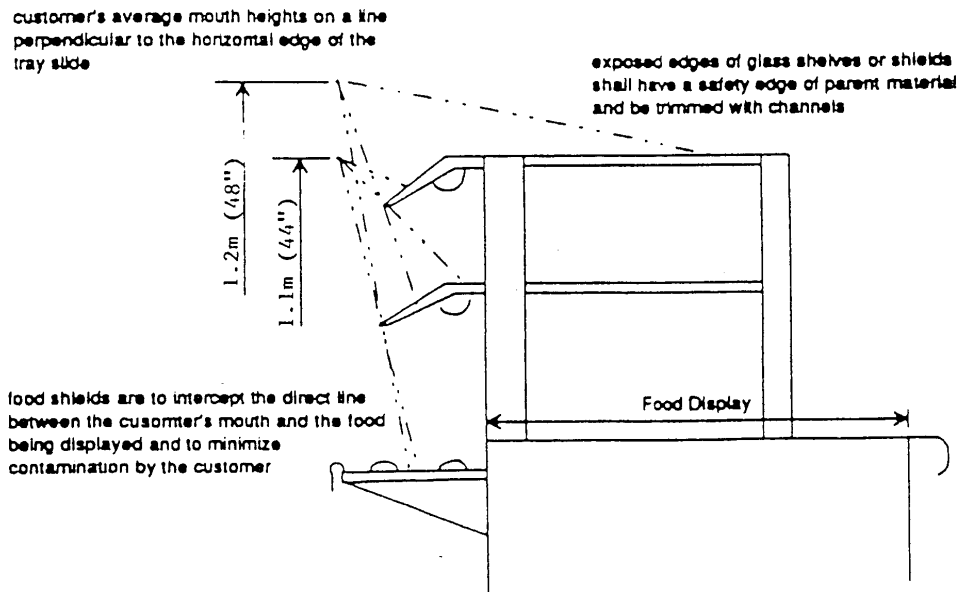
FOOD SHIELDS

# Grades 3-5

TYPICAL BUFFET TABLE



TYPICAL CAFETERIA COUNTER



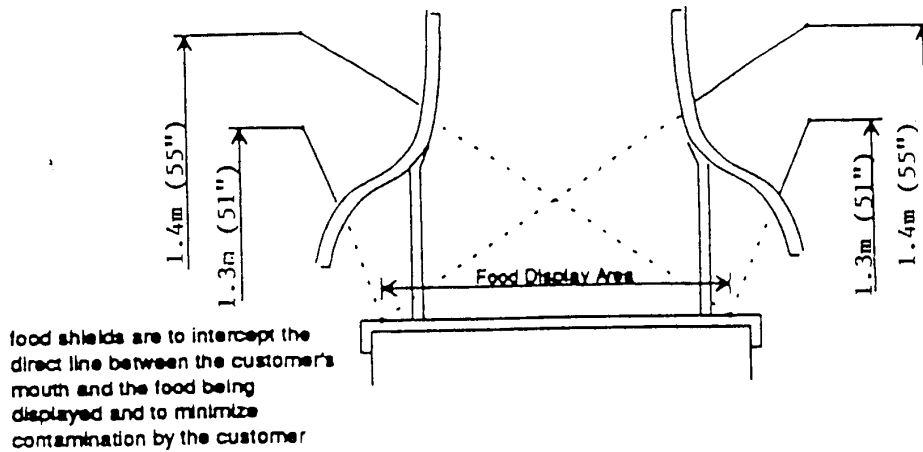
FOOD SHIELDS

# Grades 6-8

TYPICAL BUFFET TABLE

customer's average mouth heights on a line perpendicular to the horizontal edge of the buffet table

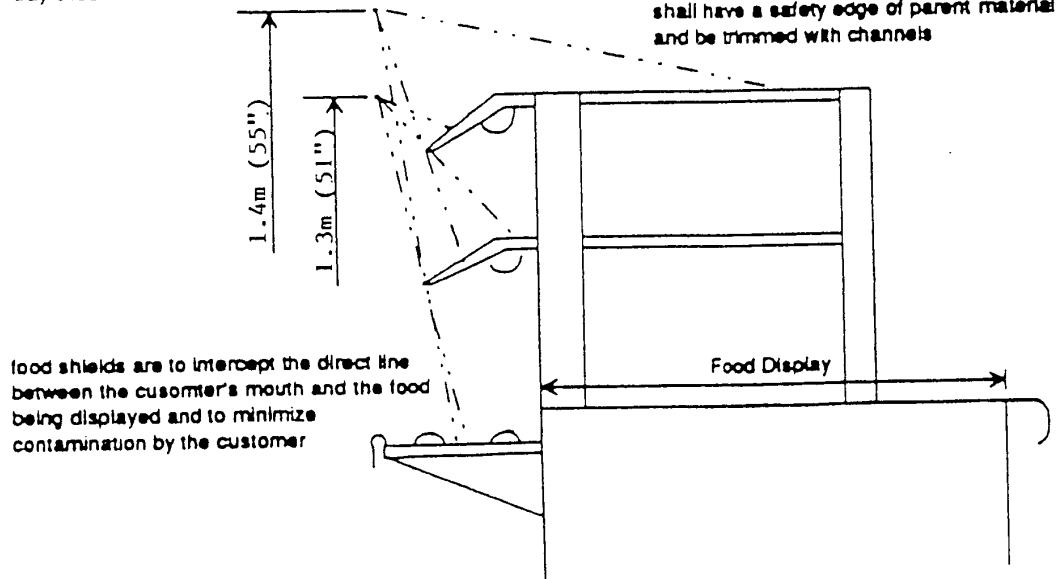
exposed edges of glass shelves or shields shall have a safety edge of parent material and be trimmed with channels



TYPICAL CAFETERIA COUNTER

customer's average mouth heights on a line perpendicular to the horizontal edge of the tray slide

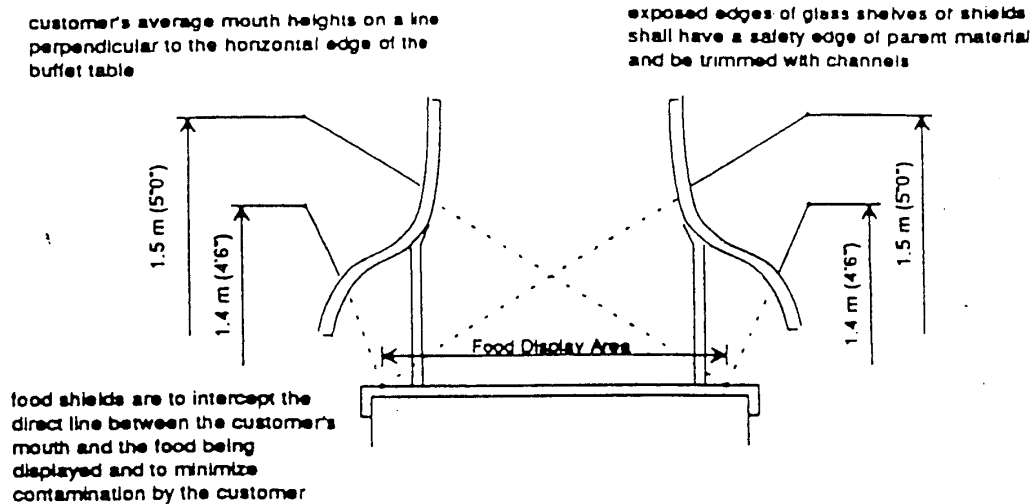
exposed edges of glass shelves or shields shall have a safety edge of parent material and be trimmed with channels



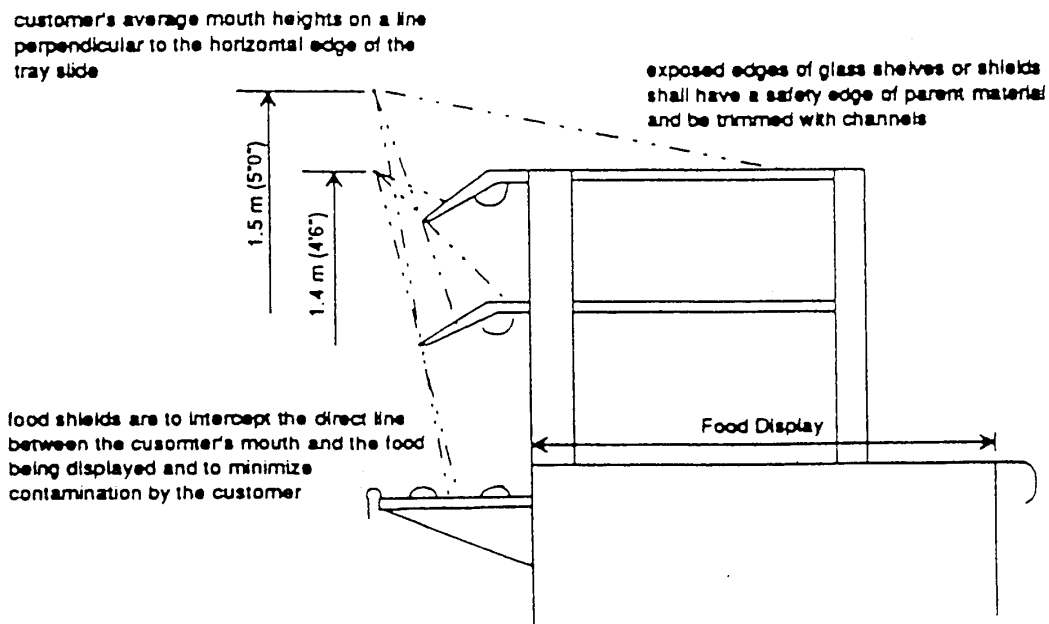
FOOD SHIELDS

## Illustration for High School Grades 9-12 And For Commercial Establishments

TYPICAL BUFFET TABLE



TYPICAL CAFETERIA COUNTER



FOOD SHIELDS